POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884

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Volume 73 NEW YORK, MARCH 24, 1931 *Number 12*

Order

THE AFFAIRS of a man of order move like a procession of habituated marchers, while those of the man who is careless, inconstant and unstable move like the surging of an undisciplined crowd.

The man of orderly habits loses no time in shuffling things about to find what to do next. He simply falls into step with his day's work. He moves in his accustomed way and things move along with him.

He has the tools and materials, the records and references for the task of the hour ready to hand. He would have the job done while one of less orderly habits would be deciding what to tackle next and getting its essentials together.

His personnel and associates know how to serve and to work with him to advantage. Their work is laid out and timed to correlate with his own. They know what to do and when and how to do it.

No man's work and no man's life, however well regulated, flows with unbroken streamlines. Emergencies will arise, interruptions will occur and accidents will happen.

The man of orderly habits is not swept off his feet by such incursions. Their resolution is a part of the day's work. And just as it is easier to restore order and re-establish progress with a drilled crew or a disciplined regiment, so it is easier for him to straighten out the confusion, decide upon the best solution of the difficulty and put the necessary measures into effect.

Order is simply a manifestation of organization, of habitual system, of accustomed readiness, of wonted attention to detail, of punctual pains to keep things as they ought to be.

Order becomes a habit and extends to mental as well as to physical processes. The man who has acquired it will do more in less time, neglect and overlook less, be more dependable, be a better workman and a more efficient executive and sail a straighter and smoother course than the perhaps more brilliant man to whom order is irksome and regularity a restraint.

EDITORIALS

A Challenge To Engineers

IT HAS often been said that engineers are not business men. From what bankers say of some engineering reports presented to them, this statement cannot be completely denied.

As politicians, the engineers, with rare exceptions, have failed to matriculate, and when they do they are apt to be regarded as backsliders by their confrères.

In civic matters they are hardly known and are but a minor force.

Yet the engineer is concededly the foundation rock of present civilization. Without him, what have become the necessaries of life would not exist.

Even so, most of the engineers work for someone else and are regarded as the sort of brains to be hired—not consulted.

Volume of correspondence shows that business men, chambers of commerce, and other broad thinkers have a deep interest in the Platform for American Business published with the March 3 issue of *Power* and contemporaneously with other McGraw-Hill papers.

They are studying it and, in recognition of its educational value, are taking active steps to spread its gospel.

They realize anything that can be done to get thought directed to the prevention of another depression is a great and constructive work.

Are the engineers doing likewise or are they—just what many people think?

Mr. Russell Joins Governor Roosevelt

FOLLOWING the dismissal of Charles A. Russell by Chairman Smith of the Federal Power Commission many predicted that the former solicitor would soon be found in the camp of Governor Pinchot of Pennsylvania, whose threatened tirade against power companies is beginning to be heard.

Therefore, to many the announcement that Governor Roosevelt of New York has retained Mr. Russell as an advisor on power matters comes as a surprise. The occasion may be the prospective negotiations concerning St. Lawrence power; for Mr. Russell, despite his admitted leanings, has had opportunity, while solicitor for the Federal Power Commission, to gain a broad background in power matters. On the other hand, should power become a major issue in the next Presidential campaign, the line-up is obvious.

A Radical Advance In Welding Codes

FOR YEARS progressive engineers have envisaged fusion welding as a means of producing better power boilers at lower cost. More recently higher pressures and embrittlement studies have furnished additional arguments for welded drums. The dream has grown into an insistent demand.

At first the wheels of the A.S.M.E. Boiler Code Committee ground slowly at the problem—not so simple as some enthusiasts thought. During the past twelve months, however, efforts have been redoubled, backed by increasing support from the welding and fabricating fields.

Now comes the grist, constantly improving in quality. The latest proposal, published in March *Mechanical Engineering* and discussed in *Power* last week, embodies the best features of previous tentative codes. At the same time it goes far beyond any of its predecessors.

The new classification of pressure vessels and grades of welding is a revolutionary advance. It surrounds vessels for severe service with every safeguard. At the same time, it does not impose commercially impossible restrictions on the makers and users of vessels subjected to easier operating conditions. The proposed code gives practical recognition to the effect of temperature upon safe stress. And finally, it puts power boiler drums where they belong—in the general classification of pressure vessels.

Some will feel, however, that the code committee has gone too far in requiring X-ray inspection of Class I vessels as a regular production procedure. All grant the extreme usefulness of radiographic inspection in the

development of sound welding procedure, but routine X-ray inspection of thick drums will undoubtedly impede shop procedure and add considerably to cost.

With apparatus now available, direct X-ray inspection by fluorescent screen is not practicable for shell thickness greater than one-half inch. Thicker shells involve the use of many photographic films, long exposures and delays for development and analysis. It is to be hoped that the code committee can devise some less burdensome method of protecting the user against the product of inexperienced manufacturers.

Other features of the code may be open to improvement. Those who have constructive suggestions are urged to send them before April 7 to the Boiler Code Committee, 29 West Thirty-ninth Street, New York City.

Hoover Dam Not a Power Project

CONSTRUCTION WORK has started on the much-discussed Hoover Dam project on the Colorado River. This development is the greatest of its kind attempted in the United States. Its large proposed power capacity has created the impression that it is a power development, but power is secondary. In this undertaking the government is following a long-established reclamation policy.

For many years the federal government has been constructing dams to store water for irrigation, navigation and river control. At several of these dams power is generated as a byproduct. At Hoover Dam the basic problems are more involved and of proportions beyond anything previously attempted. Nevertheless, it remains a water-supply and river-control project.

Floods on the Colorado River have long been a menace to people living in its lower basin, and seventy miles of levees are maintained for their protection. The unregulated maximum flow of the river is about two hundred times the minimum. Large areas of what was at one time waste land are already irrigated with its waters. When the river has been regulated the reclaimed land can be increased to three times the present area. Southern California cities have been facing a serious water-supply problem, and the construction of Hoover Dam will bring the needed relief. Eventually a billion gallons per day will be pumped from the river to these cities. This will require four hundred thousand horsepower, a large part of which is to be generated at the Hoover Dam plant.

Although the federal government is financing the construction of the power development along with the rest of the project, it will not operate the plant. This will be done by those who have agreed to purchase the power, at a rate that will pay for the construction cost, with interest, in fifty years. Seven states and Mexico have vested interests in the development. No other single agency is in a position to deal with these relationships but the federal government.

Even if the power in the project is the largest undertaking in this country, it does not put the federal government into the power business any more than do some of the irrigation projects now in service. If the only interest in Hoover Dam were power, the government would have no reason to be related to its construction except through the usual channel of the Federal Power Commission.

Dalton's Law And the Radiator

ELSEWHERE in this number are several discussions dealing with the mixing of air and steam in radiators. All agree a mixing takes place, but its extent and action have been ignored.

Those who have had occasion to battle with a cold radiator may doubt the actuality of any mixing, or even the existence of any steam. Nevertheless, some mixing does occur, although the rate is by no means rapid, and most of the air is discharged through the vent before much steam combines with the air.

Apparently, when the radiator valve is first opened the entrance of steam forces the air toward and out of the air vent. While this flow is taking place, some steam molecules start to pass between the air molecules, the rate of penetration depending upon the density of the steam. At the same time a like diffusion of the air into the steam mass takes place. At any given plane where there is a mixture, Dalton's Law of partial pressures exists, and the sum of the air and steam pressures is equal to the steam pressure in the inlet part of the radiator or the air pressure toward the vent end.

The diffusion process is less active than in an insulated chamber, for the condensation of the steam reduces its rate of penetration. If the vent were closed and sufficient time allowed, the steam and air would completely mix, and some air would back flow to the boiler, so that in the entire system a mixture would exist, the pressure of which would follow Dalton's Law. But in the working radiator, this law of partial pressures does not hold true save in a more or less limited zone of diffusion.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Detroit's New Springwells Pumping Station

It will consist of low-lift and high-lift motor-driven centrifugal pumping plants, a 20,000-kw. modern steam turbine generating station to supply the power, a filtration plant and large filtered-water storage reservoirs

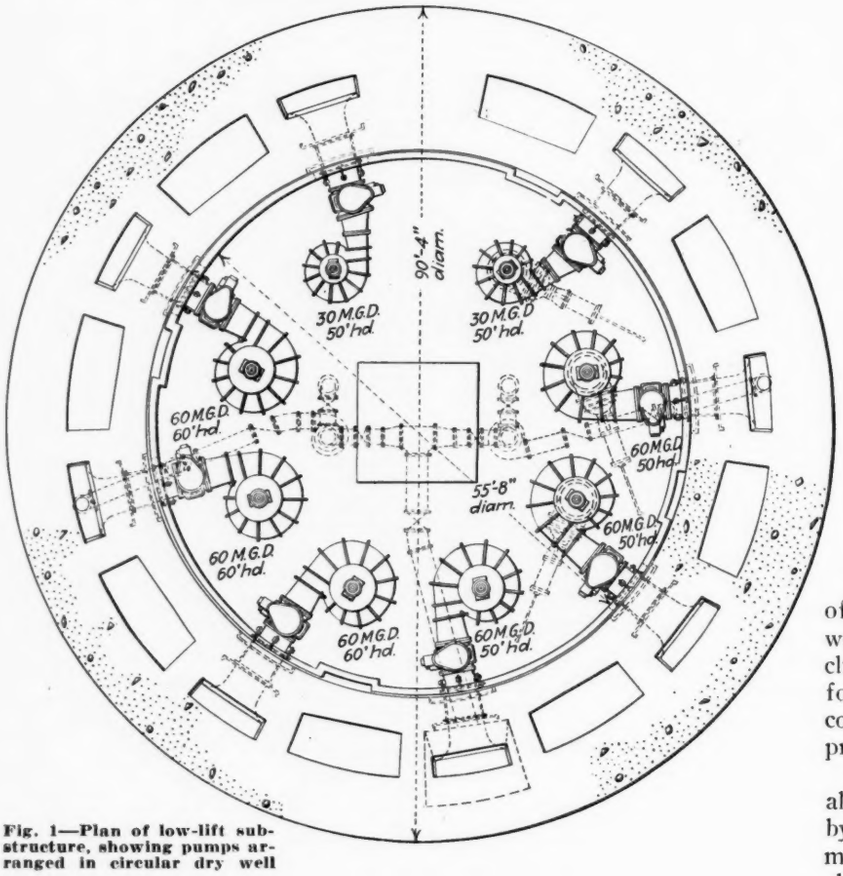


Fig. 1—Plan of low-lift substructure, showing pumps arranged in circular dry well

ABOUT ten years ago the city of Detroit began to realize that existing water supply facilities soon would become inadequate. The Board of Water Commissioners began a comprehensive study of the requirements, which eventually resulted in an adequate expansion program calling for two additional plants, one in the northwestern section of the city and the other in the northeastern section. Water will be brought to the two new stations from an intake in the river through concrete tunnels built under the streets. At each plant there will be a complete works, consisting of low-lift and high-lift pumping plants, a filtration plant, reservoirs, and, in the case of the first of the plants to be built, a complete power plant supplemented by central station standby service.

The proposed plant in the northeastern section of the city will not be started for a number of years, but the works that is to serve the northwestern section is now under construction and will be completed the latter part of 1931. These works will be known as the Springwells station. The plant is being designed for an average daily capacity of 206,000,000 gal., with a maximum day output of 300,000,000 gal.

Preliminary to laying out the design of the low-lift plant 21 arrangements were considered, with the resulting conclusion that the circular type of structure for the low-lift pumps had the lowest cost and in other ways would best meet prevailing conditions.

Several forms of power plant design also were given careful study and analysis by the water board's engineers, having in mind primarily the cost, but also adaptability for the service and reliability. Preliminary designs were carried out on four specific plans as follows:

Plan 1—Centrifugal horizontal-shaft pumps in both the high-lift and low-lift plants, with steam-turbine, reduction-gear drives.

Plan 2—Combination high- and low-lift plant using motor-driven centrifugal pumps, the motors to be synchronous and variable-speed, slip-ring types. Power for the motors to be furnished by turbine-generators, with an outside source of power from central station service for emergency.

Plan 3—Low-lift plant using water-turbine-driven centrifugal pumps; and steam-turbine, reduction-gear-driven centrifugal pumps in the high-lift plant. Water power for the low-lift pumps to be furnished by the high-lift pumps and the water returned to the reservoir to be repumped.

Plan 4—Low-lift pumps to be driven by direct-current motors of the horizontal-shaft type; and steam-turbine, reduction-gear-driven centrifugal pumps in the high-lift plant. Power for the direct-current motors to be furnished by turbine-generators, with a central station source of power for emergency.

First of all, it was decided that electric power for

operating the pumps should be supplied by a steam-turbine generating plant located on the site, and that central station power also should be made available. Greater reliability for water-works service and more economical operation were the primary reasons.

Motor-driven centrifugal pumps were considered more economical in this case than steam-turbine drive and reduction gearing. The electrical connections between the turbine-generator plant and the motors driving the pumps could be so arranged that any pump could be operated on power generated in the plant or supplied from the utility. With the capacity of the central station service not less than the equivalent of one of the turbine-generators, plant capacity in turbine-generators need be only equal to the maximum demand, as the outside power would be able to meet emergencies and could be considered as standby service. Relative construction and operating costs of the several types of plants proposed appear in the table. These estimates were favorable to Plan 2, which was adopted.

ESTIMATED CONSTRUCTION AND OPERATING COST OF THE FOUR PLANS CONSIDERED

	Plan 1	Plan 2	Plan 3	Plan 4
Comparative Constr. Cost	$2,319,050	$2,316,560	$2,559,360	$2,537,050
Comparative An. Oper. Cost	619,630	588,160	622,110	638,470

An accompanying illustration indicates the circular substructure adopted for the low-lift plant. It was built as an open caisson 90 ft. in diameter and about 94 ft. below grade, 65 ft. of which was sunk as a caisson. With walls 8 ft. thick, this caisson is one of the largest ever constructed. It was sunk in soft blue clay and through 14 ft. of hardpan. Inside of the caisson, an inner wall has been constructed, and within this circular type of dry well, having a diameter of about 56 ft., will be the pumps. As the pumps will be placed about 65 ft. below the surface, they will be of the vertical-shaft motor-driven type. There are to be ten of them, having capacities ranging from 7.2 to 60 m.g.d., with heads of 50 and 60 ft. The gross capacity of the ten pumps will be 435,000,000 gal. per day.

Housed in the same building, the high-lift plant ultimately will be equipped with sixteen units arranged in pairs and set in individual pits inside the building 19 ft. below grade. The aggregate capacity of the sixteen units will be 680 m.g.d., but for the present only twelve pumps are to be installed, with a total rated capacity of 500 m.g.d. These pumps will be of the horizontal-shaft centrifugal type driven by electric motors arranged for remote control. They will be in sizes of 30, 40 and 50 m.g.d. each, and will be divided into two different groups. One set of pumps, operating against a head of 150 ft., will deliver water into the distribution system leading to the southeast and southwest districts of the city. The second group of pumps will operate against a head of approximately 200 ft. and will deliver water to the northwest district.

Since the filtered water is to be pumped to direct-pressure systems, it will be necessary for the pumps to follow the load. Because variable-speed drive for centrifugal pumps are inefficient, it was decided to use about 80 per cent of the pump capacity in constant-speed, synchronous-motor-driven units and the balance in slip-ring, induction, variable-speed, motor-driven pumps. With this arrangement the difference in capacity will be affected by interchange in the size of the units and in speed control of the slip-ring motor-driven pumps. Three-phase, 60-cycle current at 4,600 volts, which is generator voltage, will be supplied to the motors.

Power for the operation of the pumps will be secured from a plant that eventually will contain four 5,000-kw. turbine units generating 4,600-volt, 3-phase, 60-cycle current. Two of these units will form the initial installation. The plant will operate in parallel with central station service equivalent to the capacity of one main generator. Arrangements will be made to use a small portion of central station power at all times and in emergency to draw sufficient power to replace one main turbine in case of failure during peak loads. These main units will operate condensing; each will be equipped with a two-pass surface condenser having 10,000 sq.ft. of surface. Steam will be extracted at two points for heating the feed water. The condensate will be pumped through the two extraction heaters of each unit and then to the economizers and into the boilers. Anticipated feed-water temperatures are 270 deg. F. as the water enters the economizer and 370 deg. upon delivery to the boilers.

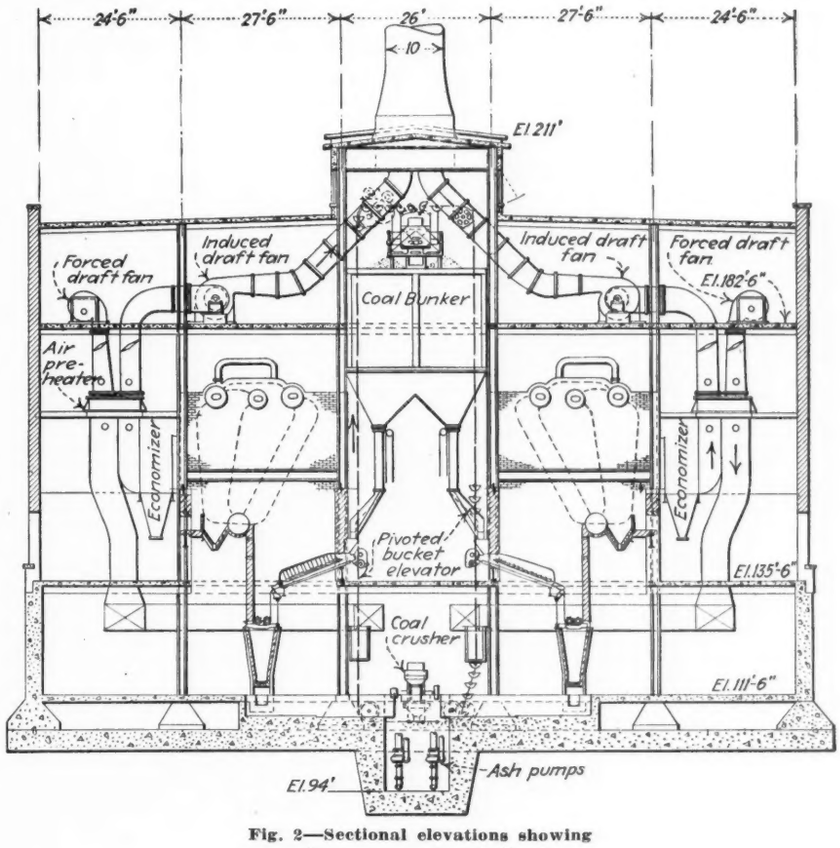


Fig. 2—Sectional elevations showing general arrangement of boiler house

Physical Data and Cost of Mechanical Equipment in Springwells Station

Low Lift Pumps

Eight motor-driven, vertical centrifugal pumping units, Worthington Pump & Mach. Corp.

Eight driving motors.....General Electric Co.

Three 60-m.g.d. pumps, constant speed, 50-ft. head; 42-in. suction, 36-in. discharge; synchronous-motor drive, 4,600 volts, 3 phases, 60 cycles. Three 60-m.g.d. pumps, constant speed, 60-ft. head; 42-in. suction, 36-in. discharge; synchronous-motor drive, 4,600-volts, 3-phases, 60-cycles. Two 30-m.g.d. pumps, variable speed, 50-ft. head; 36-in. suction, 36-in. discharge; variable-speed slip-ring induction motor drive, 4,600-volts, 3 phases, 60 cycles.

Total cost of pumps, including electrical equipment $133,857

Dewatering and Sump Pumps for Low-Lift Plant

Four motor-driven centrifugal pumping units, American Well Works

Two 2-speed vertical motor-driven dewatering pumps, 5,000 g.p.m., 55-ft. head; 16-in. suction, 16-in. discharge.

Two constant-speed horizontal motor-driven sump pumps, 300 g.p.m., 100-ft. head, 4-in. suction, 3-in. discharge.

Motors all of squirrel cage type.

Total cost, including electrical equipment.....$13,365

Passenger Elevators, Low-Lift Plant

One direct-current traction type passenger elevator, Otis Elevator Co.

Live lifting capacity, 2,000 lb.; speed, 200 ft. per min.

Cost complete with auxiliaries and accessories..$5,783

High-Lift Plant

Twelve motor-driven horizontal centrifugal pumping units, Worthington Pump & Mach. Corp.

Motors, 4 var.-sp. slip-ring; 8 synchronous, General Electric Co.

Two 30-m.g.d. pumps, variable-speed, 200-ft. head, 28-in. suction 20-in. discharge. Two 40-m.g.d. pumps, variable-speed, 130-ft. head, 36-in. suction, 30-in. discharge. Four 40-m.g.d. pumps, constant-speed, 200-ft. head, 32-in. suction, 24-in. discharge. Two 50-m.g.d. pumps, constant-speed, 150-ft. head, 42-in. suction, 36-in. discharge. Two 50 m.g.d. pumps, constant-speed, 130-ft. head 42-in. suction, 36-in. discharge.

Water Check Valves for Pumping Units

Nine water check valves, cone automatic type, 125-lb. pressure, handwheel throttling; aut. control accomplished by velocity of water on electrical operation, Automatic Cone Valve Co.

Costs ready for service:

Two 16-in.	$3,163
Three 20-in.	6,740
Four 36-in.	20,380
Total	$30,283

Eight water check valves, needle type Larner-Johnson hydraulic, 125-lb. pressure; throttling accomplished by extension stem and handwheel limiting automatic opening; automatic control accomplished through solenoid valve, I. P. Morris and DeLaVergne, Inc.

Costs ready for service:

Two 24-in.	$8,130
Six 30-in.	28,700
Total	$36,830

Crane for Pumping Plant

One bridge crane, 40-ton.....Northern Engineering Works

Cost of crane complete $20,230

Switching Equipment and Motor-Generator Sets for Pumping and Power Plants

Award to .....Westinghouse Elec. & Mfg. Co.

Pumping plant switchboard, 60 panel; 35 panels main sw.bd., 24 contactor and relay panels, 1 phantom sw.bd.

Power plant switchboard, 37 panels; 27 panels main swbd. and 10 relay panels.

Main switch gear, 53 metal clad oil circuit-breaker units; 44 of 600-amp. cap.; 9 of 1,600-amp. cap. at 7,500 volts.

Auxiliary switchgear; 24 units of switch gear for 460-volt, 3-phase, a.-c. aux. system; 13 panels for d.-c. breakers; 3 oil circuit breakers for starting equipment of three 300-kw. motor-generator sets.

Reactors, 75 single-phase, air-cooled, air core, dry type; 54 for starting syn. motors, 9 for starting 300-kw. motor-generator sets, and 12 for main bus.

Control, resistors and contactors for 6 slip-ring variable-speed motors.

Motor field rheostats, 18, motor-operated, for syn. motors.

Motor-generator sets; three 300-kw., 435-hp. syn motor, 1,200 r.p.m.; three 50-kw. 75-hp. ind. motor, 1,750 r.p.m.

Total cost $314,368

Automatic Telephone System

51 telephones, 100-line board.....Automatic Electric, Inc.

Cost complete $5,429

Turbine Generators and Auxiliaries

Turbine-generators, two 5,000-kw.....General Electric Co.

Turbines, horizontal, extraction types; steam 350 lb., 700 deg. F.; generator 6,250 kva.; 4,600 volts, 3 phases, 60-cycles; 3,600-r.p.m.; exciter, 35 kw., 250 volts; generator air coolers.

Cost ready for service $171,500

Condensing equipment for 5,000-kw. turbines, C. H. Wheeler Mfg. Co.

Condensers, two 2-pass, semi-dual bank surface; condense 60,000 lb. per hr. of steam, b.p. 1½ in. hg., cooling water 70 deg., 7,850 g.p.m. of cooling water.

Circulating-water pumps, four, 4,025 g.p.m., 11.6-ft. head, 16-in. inlet, 14-in. outlet; efficiency, 83 per cent; drive, four 20-hp. G. E. motors.

Steam jet air ejectors, Radojet 2-stage with surface inter- and after-condenser; steam consumption, 280 lb. per hr.

Cost of condensing equipment.....$63,910

Hotwell pumps, four 2-stage, 250 g.p.m., 200-ft. head; 6-in. suction, 4-in. discharge; drive, two 30-hp., 230 volt, d.-c. motors....Worthington Pump & Mach. Corp.

Total cost $4,982

Turbine-generators, three 500 kw.....General Electric Co.

Turbine, impulse six-stage, extraction type; steam 350 lb., 700 deg.; generator 625 kva., 460 volts, 3 phases, 60 cycles, 3,600 r.p.m.; exciter 11 kw., 250 volts; generator air cooler, 635 sq.ft.

Cost of three units.....$72,250

Condensing equipment for 500-kw. turbines, Worthington Pump & Mach. Corp.

Condensers, three, 2-pass, 800 sq.ft.

Circulating, water pumps, three, 1,750 g.p.m., 17-ft. head; drive, 10-hp., d.-c. G.E. motor, 850 r.p.m.

Condensate pumps, three, 17 g.p.m., 100-ft. head; 2-in. inlet; drive 1½-hp. d.-c. G.E. motor, 1,800 r.p.m.

Air ejectors, double type with inter- and after-cooler; steam consumption with steam 350 lb. and 700 deg., 110 lb. per hour.

Cost of condensing equipment.....$15,370

Feed-Water Heating Equipment

Award to .....Griscom-Russell Co.

Heaters, low-pressure, two, 60,000 lb. per hr. from 100 to 193 deg. F.; surface, 430 sq.ft. Heaters, high-pressure, two 60,000 lb. per hr. from 193 to 259 deg. F.; surface, 241 sq.ft.

Evaporators, single-effect, two 2,000 lb. vapor per hr. at 12 lb. abs. pressure; surface, 42.8 sq.ft.

Heat exchangers, two, cool 30,000 lb. condensate from 180 to 110 deg. F.; surface, 308 sq.ft.

Pressure for which heaters and evaporators designed: shell, 125 lb.; tubes, 150 lb. Working pressure of heat exchangers; shell, 50 lb.; tubes, 150 lb.

Cost of equipment $11,119

Boiler Feed Pumps

Pumps, three 3 in., 6-stage cent., Pennsylvania Pump & Compressor Co.

Capacity, 300 g.p.m.; head, 1,050 ft.; speed, 1,750 r.p.m.

Cost complete $8,202

Boilers and Auxiliaries

Boilers, two, 4-drum water tube..Combustion Engineering Corp.

Surface, 10,388 sq.ft.; steam, 70,000 lb. per hr., 375 lb. pressure; plain-tube water-cooled walls.

Cost $66,566

Superheaters, two, convection.....Superheater Co.

Surface gas touched, 1,720 sq.ft.; steam touched, 1,400 sq. ft.; capacity, 70,000 lb. per hr.; steam temp. sup. inlet, 442 deg.; superheater outlet, 710 deg.

Cost $11,365

Economizers, two, w.s. return-bend loop type, Babcock & Wilcox Co.

Active surface, 2,430 sq.ft.; 70,000 lb. water per hr., temp. at inlet, 260 deg.; at outlet, 321 deg.

Cost $16,750

Air preheaters, two, Ljungström type....Air Preheater Corp.

Active surface, 9,980 sq.ft.; air supplied, 92,500 lb. per hr.; temp. at inlet, 70 deg.; at outlet, 312 deg.

Cost $11,742

Stokers, two, underfeed.....Westinghouse Elec. & Mfg. Co.

Projected grate area, 190 sq.ft.; 8 retorts, 27 tuyères.

Cost $26,735

Fans, forced-draft, two.....Green Fuel Economizer Co.

Capacity, 45,000 c.f.m.; 13.5 in. water; speed 1,660 r.p.m.

Cost with all accessories.....$9,288

Fans, induced-draft, two.....Green Fuel Economizer Co.

Capacity, 75,000 c.f.m.; at 11 in. of water; speed, 1,130 r.p.m.

Cost with all accessories.....$12,861

Coal-Handling Equipment

Award to .....Link-Belt Co.

Drag scraper and tail car, one, 2-cu.yd.; 75-hp. G.E. motor .....R. H. Beaumont Co.

Apron feeder with magnetic headshaft, one, 36-in., 100 tons at 14 ft. per min.; 5-hp. G.E. motor..Link-Belt Co.

Crusher, ring type, one, 100 tons per hr.; 30-hp. G.E. motor .....American Pulverizer Co.

Pivoted-bucket elevator, one, 30-in., 100 tons per hr. at 50 ft. per min.; 15-hp. G.E. motor.....Link-Belt Co.

Belt conveyor and tripper, one 24-in.; 75 to 100 tons per hr. at 300 ft. per min.; 5-hp. G.E. motor.....Link-Belt Co.

Cost complete $33,790

Ash-Handling System

Award to..W. E. Wood Co. (Allen-Sherman-Hoff equipment)

Ash hoppers under boilers with sluicing nozzles, doors, lining and quencher system. Soot and sifting gates and pipes to ash hoppers. Sluiceway castings including liner castings for two boilers and c.i. curb frames and cover plates for four boilers.

ers and c.i. curb frames and cover plates for four boilers.

Ash pumps, two 1,000 g.p.m., 102-ft. head; suction pipe lines with valves and inlet agitators; drive, 100-hp. G.E. motor, 900 r.p.m.

Clinker grinder, one, stationary; drive, 15-hp. hor. motor, 600 r.p.m.

Ash-storage bin with lining plates and two ash gates.

Discharge lines from pumps to ash storage bins.

Cost of equipment complete.....$55,320

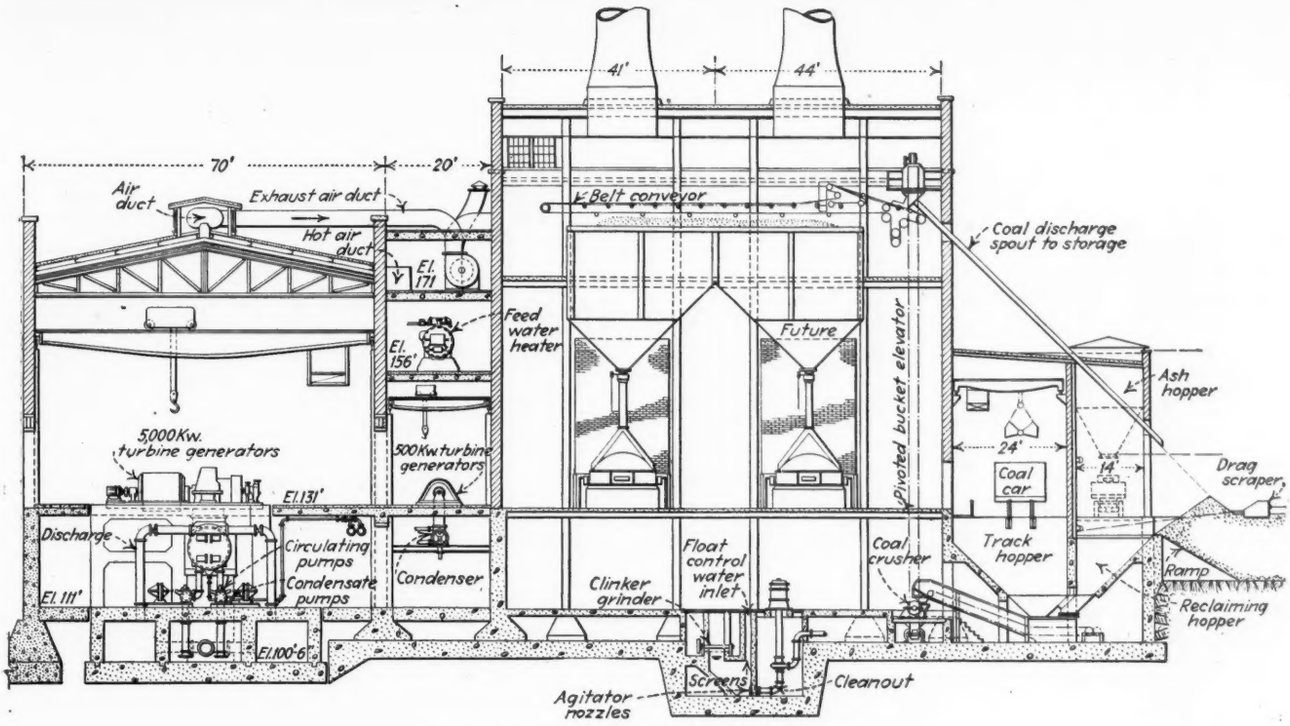


Fig. 3—Sectional elevation through power house

It is planned to install four 500-kw. turbine-generators to supply the auxiliary power. Three of these machines are on order. They will deliver 460-volt, three-phase, 60-cycle current to motor-generator sets that, in turn, will supply 240-volt direct current for the essential auxiliaries. Other than essential auxiliaries in the power, pumping and filtration plants, and the lighting, will be operated on 440-volt alternating current. Each of these generating units will be equipped with an 800-sq.ft. surface condenser, but steam will be bled from an intermediate stage of the turbine to heat the various buildings, the calculated maximum requirements reaching 30,000 lb. of steam per hour based on steam at 5 lb. gage pressure.

In the switch house adjoining the turbine room there will be two control rooms, one for the pumping plant and one for the power plant. All pumps will be controlled from one point by a single operator, and one operator will control the prime movers and auxiliary units in the power plant. On the top floor of this building will be located the fans for ventilating the pumping plant: Forced-draft fans will blow fresh air into the motor pits and a group of exhaust fans will draw air from the top of the building. On the second floor will be located the oil circuit-breakers and switchboards, and on the first the reactors, resistors, rheostats and similar equipment.

Designs for the boiler plant called for four 10,000-sq.ft. boilers to generate steam at 360 lb. gage pressure and at a total temperature of 715 deg. F. The initial installation will consist of two boilers of the four-drum bent-tube type, equipped with water-cooled side walls and fired by motor-driven underfeed stokers. Economizers will raise the temperature of the feed water to 370 deg. and air heaters will deliver combustion air to the stokers at about 300 deg. Motor-driven forced- and induced-draft fans will be arranged on a fan floor above the boilers.

Some idea of the coal- and ash-handling systems will be obtained from the sectional elevations of the boiler house. Incoming coal cars may be unloaded directly into the track hopper or by means of a bucket-equipped traveling crane. From the hopper the coal will be fed through a crusher to a pivoted bucket carrier which on its upper run will deliver to a distributing belt conveyor, the latter passing over a 600-ton concrete-lined bunker located above the central firing aisle of the boiler room.

Ashes will be handled by hydraulic sluicing. From the ash hoppers under the stokers, they will be sluiced to a central pit equipped with clinker grinders. Water under float control will be admitted to this pit, so that the ashes may be pumped to an overhead tank for delivery to trucks or railroad cars.

One of the features of the coal-handling system is spout delivery of the coal to open storage from the upper run of the pivoted bucket carrier. When needed, this storage coal will be reclaimed to the track hopper by means of a drag scraper and will be carried to the bunker in the usual way.

An unusual feature of the power plant will be its ability to start large pump motors, as the plant capacity is relatively small compared to the motor ratings.

The plants are being designed and constructed by the Board of Water Commissioners, of which Alex. Dow, president of the Detroit Edison Company, is engineer-member, and under the general direction of George H. Fenkell, general manager and chief engineer, assisted by Frank H. Stephenson, engineer of water system and assistant chief engineer. The Bureau of Power, in charge of W. C. Rudd, is responsible for the design of the pumping and power plants. Bernard J. Mullen, assistant mechanical engineer, supervises the mechanical and hydraulic designs and Carl J. Schoeninger, chief electrical inspector, is in charge of electric power, lighting and electric equipment. Ayres, Lewis, Norris & May, of Ann Arbor, were consultants on hydraulic and electrical design and, E. R. Little Company, of Detroit, is designing the heating, ventilating and plumbing systems. The architect is John C. Thornton, of Detroit.

Mechanical-Type

VARIABLE-SPEED TRANSMISSIONS—II

By F. A. ANNETT
Associate Editor of POWER

In the March 10 number the sliding friction disk, the parallel cone pulley, and the adjustable V-shaped pulley types of variable-speed transmission were described. This article explains the operation of types using the principle of adjustable friction cones, a constant-throw eccentric with an adjustable-throw clutch, an adjustable-throw eccentric with clutches, and the Weiss type

THE VARIABLE-SPEED transmission, Fig. 15, operates on the principle of a variable-ratio planetary gear, but instead of gears conical-shaped rollers are used. *S* is the constant-speed input shaft and *S'* the variable-speed output shaft. On the input shaft are mounted the two inner races. These are secured to it by feather keys that permit movement of the races along the shaft. These races press toward each other by heavy springs *R* as indicated in Figs. 12 and 15.

On the output shaft *S'* are three planetary rollers *P*, two of which can be seen in Fig. 15. The springs *R* on the input shaft force the inner race against the planetary rolls and press them out into the outer race *O* and *O'*. This outer race is adjustable by the control wheel *W*, which is attached to *O*.

When the input shaft is revolved the inner race turns with it and revolves the planetary rolls in the outer race and drives the output shaft. When the outer race is closed, as in Figs. 13 and 15, the inner race is riding on the smallest diameter of the planetary rolls, and the largest diameter of the planetary rolls is riding on the outer race. Consequently the planetary rolls travel at a maximum speed about the outer race, and there is a minimum speed reduction between the input and output shafts.

When the outer race is separated to the maximum position, as in Fig. 14, the inner race is riding on the large diameter of the planetary rolls, and the outer race on the small diameter of these rolls. This condition produces a minimum speed of the planetary rolls for a given speed of the input shaft, resulting in a minimum speed of the output shaft.

A maximum speed adjustment range of 1 to 5 can be obtained with variable-speed transmissions of this type. They are built in sizes up to 18-hp. capacity. By including a planetary-type speed reducer built in as part of the transmission, speed reduction of 1 to 40 may be had. For example, if the speed of the input shaft is 1,200 r.p.m. the minimum speed of the output shaft would be 30 r.p.m., and the speed of this shaft could be adjusted between 30 and 150 r.p.m. Either manual, remote or automatic control may be used.

With the variable-speed transmission, Figs. 16 and 17, speed changes are obtained by the use of a constant-throw eccentric and a variable-throw clutch. In Fig. 17 *S* is the input shaft and *V* the adjustable-speed shaft. On the input shaft an eccentric is connected to a rocker

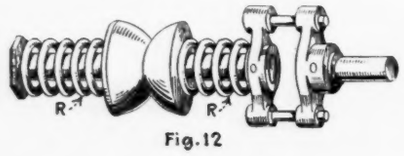


Fig. 12

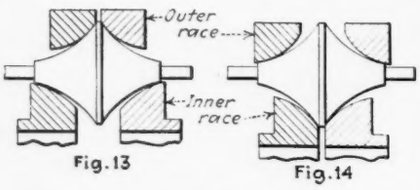


Fig. 13 Fig. 14

Fig. 12—Input shaft and inner race for Fig. 15
Figs. 13 and 14—Outer race, for Fig. 15

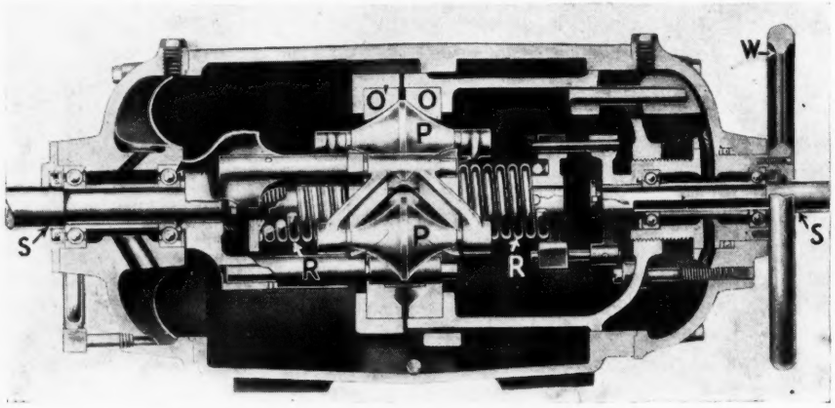


Fig. 15—Columbia and Stephenson-Adamson variable-speed transmission

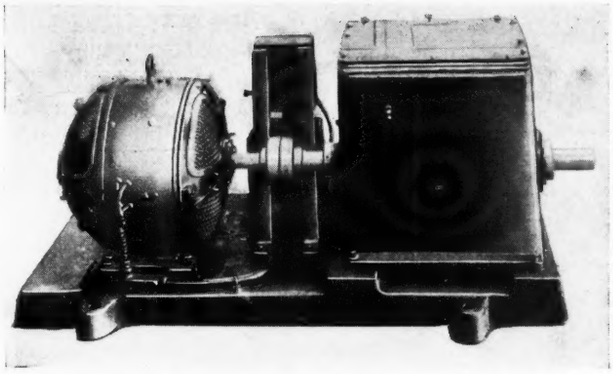


Fig. 16—Driscoll variable-speed transmission unit coupled to a motor

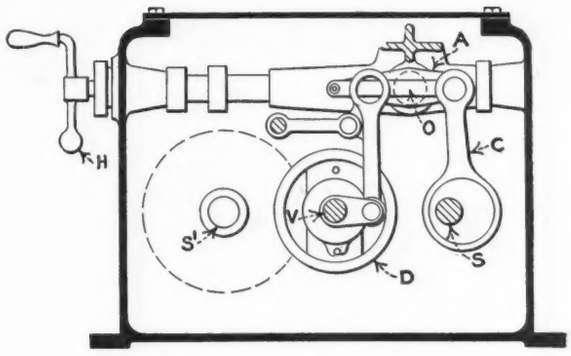


Fig. 17—Diagram of the variable-speed transmission shown in Fig. 16

arm A by a connecting rod C. A steel drum D is keyed and shrunk on to the adjustable-speed shaft V. Inside the drum and mounted free on the adjustable-speed shaft is a clutch, free to move around the shaft in one direction, but in the other it makes positive engagement with drum D. The clutch is connected to the rocker A by an adjustable connection.

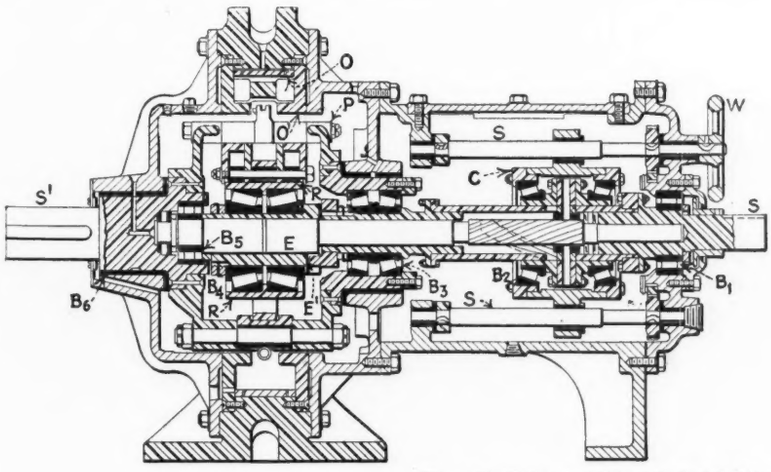
As the input's shaft is revolved the eccentric turns with it and the connecting rod C imparts an oscillating motion to rocker arm A about center O. This motion is, in turn, transmitted to the clutch. In one direction the clutch moves freely, but in the other it engages the drum and turns the adjustable-speed shaft. Only one eccentric and clutch are shown in the figure, but in practice two or more are used. When one clutch is free the other is engaged, consequently the adjustable-speed shaft is caused to turn at a constant rate.

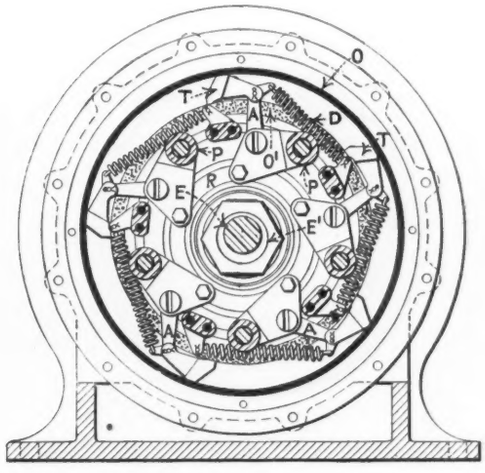
Speed adjustment is obtained by turning handle H, which, through a screw, moves the clutch connecting rod connection on rocker arm A toward or away from center O. When the clutch connecting rod's upper connection coincides with center O the clutch has no motion and the adjustable-speed shaft's speed is zero. With the connecting rod moved to the end of the rocker arm the clutch has its greatest motion and the highest speed is imparted to the adjustable-speed shaft. The adjustable-speed shaft V is geared to the output shaft S', to give any desired speed ratio.

As shown in Fig. 16, the unit is self-contained in a dustproof casing. All moving parts are run in an oil bath. The unit can be mounted on a common base with the driving motor to form a completed power unit, as in the figure, in size up to 10 hp. Input shaft speeds up to 1,800 r.p.m. may be used for standard equipment, with the adjustable-speed shaft operating over a range of from zero to about 30 per cent of the input speed. Special machines can be had that will deliver at the output shaft from zero to 75 per cent of the input speed. Standard machines can also be obtained that have the adjustable-speed shaft made reversible by throwing a small lever on the transmission. For example, if the input shaft's speed were 1,500 r.p.m. the speed of the output shaft could be 0 to 430 r.p.m. in either direction.

The variable-speed transmission, Figs. 18 and 18A, consists of an adjustable-throw eccentric on the input shaft, driving five clutches through toggle joints mounted between two stationary disks. The input shaft consists of the part in bearings B_1, B_2, B_3, B_4 and B_5. The output part of the unit is carried on the bearing B_3, B_4 and B_6. On the left-hand end of the input shaft is the variable-throw eccentric E and E'. As the eccentric is shown, the major portions of E and E' are on the lower side of the center line of the unit.

Adjustment of the eccentric is made by turning the handwheel W, which operates the threaded shafts S and shifts collar C along the splined input shaft. This collar is connected to the inner shaft so that as it is moved the two shafts are turned relative to each other and change the relative position of the eccentrics E and E'. When E is turned 180 deg. with relation to E' from the position in the figure, its throw is opposite to that of E' and no eccentric exists in the input element. Under this condition the output element is stationary, as will be shown later.





Figs. 18 (left) and Fig. 18 A (right)—Cross-sections of the variable-speed transmission Fig. 19

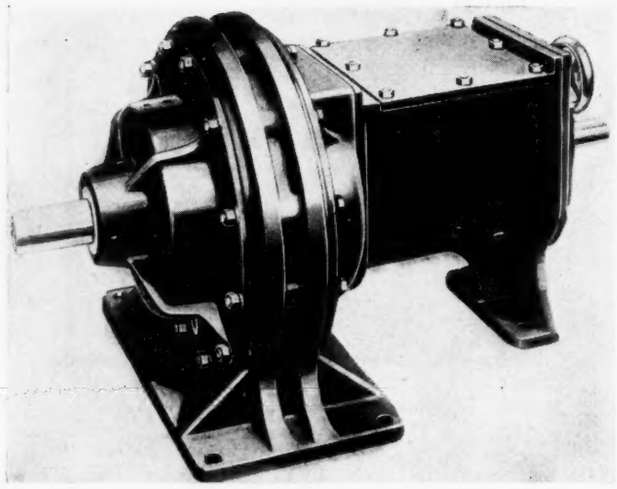


Fig. 19—Universal Gear, revocentric infinitely variable speed reducer

Outside of the input element bearing B_4 is a floating ring R that is oscillated by the adjustable eccentric. Referring to Fig. 18A, the adjustable eccentric is at E and E' and the floating ring at R. This ring is connected to the output element at five points P by a toggle system. To these toggle joints are connected five clutches T that operate between stationary inner and outer rings O and O', respectively.

When the eccentric approaches the point where a toggle plate connects to the floating ring R the plate and ring start to move outward. When this happens the clutch attached to the plate locks between the two stationary rings and prevents further outward movement. As a result the eccentric forces the toggle plate ahead and with it the output element.

When the throw of the eccentric passes a toggle point the clutch is released and the spring returns it to its original relation with the toggle plate. A study of the position of the connections A between the clutches and the toggle plates will show the action of the eccentric on the toggle system and how the output element is revolved. The throw of the eccentric, as shown in the Fig. 18A, is at the bottom, and connections A make a considerable angle with the center lines. This shows that as the eccentric revolves, in a clockwise direction, the toggle plates, and with them the output element are pushed in the same direction. The top connection A is practically parallel with the center line, which is the position when the clutch is released and returned to its inactive position by spring D.

This explains the action which takes place as the eccentric passes each toggle plate and the output element moves forward in the same direction as the input element. It is evident that the amount of forward motion of the output element depends upon the amount of throw of the eccentric. By varying the throw of the eccentric the speed of the output element can be varied from zero to 1/13 of the input speed. The units are built in size up to 15 hp. and may be controlled either manually or automatically. This type of variable-speed transmission is not reversible and, as built, the input and output shafts rotate in a clockwise direction.

Another type of variable-speed transmission that uses a variable-throw eccentric and clutches is shown in Figs. 20 and 21. In this design one-way clutches H are inside five planet gears J of a planetary gear system. Referring to the bottom cross-section, Fig. 20, the input element is carried in bearings X, Y and Z and the output element runs in the bronze bearings T and the ball bearing S. The driving connection between the input and the output elements is by five crankshafts, one of which is shown at F. One end of the crankshafts connects into a free-running oscillating disk E, in sliding bronze blocks G. The other end of each crankshaft connects to a one-way clutch H in the planet gears J. The one-way clutches are so arranged that when the connection to the oscillating plate is moved away from the center of the unit the planet gear is turned a small amount. When the crankshaft connection to the oscillating plate moves toward the center of the unit the clutch releases the planet gear.

The torque and motion delivered by the motor to the input element and transmitted through the two spline shafts A and B, which drive the adjustable eccentric C, and D imports an oscillating motion to the disk E. The amount of the oscillation, or throw, of disk E is controlled by the inner eccentric C. When the two eccentrics are opposed they rotate in E without producing any oscillating motion. When the throw of the two eccentrics coincide, as in the figure, disk E is given a maximum of oscillating motion.

Each of the five crankshafts, connected to oscillating

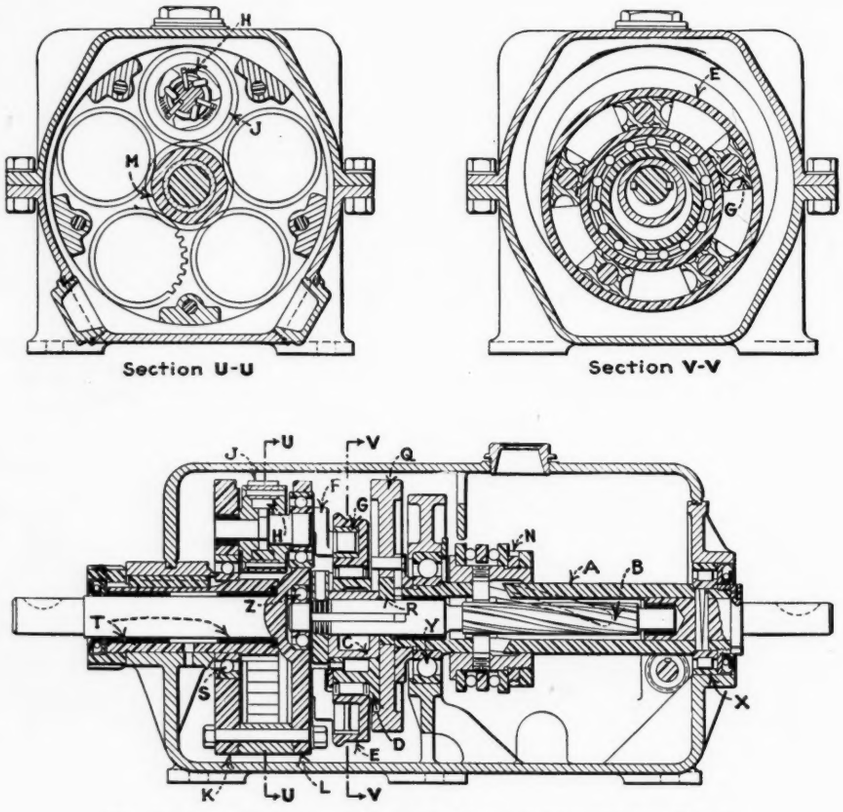


Fig. 20—Cross-sections of the variable-speed transmission Fig. 21

disk *E*, in turn, through the one-way clutches in the center of the planet gear wheels *J*, transform the oscillating movement into a rotary motion and drive the planet gears around the stationary sun gear *M*. The planet gears *J* are mounted between two steel disks *K* and *L*, which constitute part of the output element; therefore as each gear is rotated about the sun gear its unit movement is transferred to the output shaft, resulting in a uniform angular velocity and torque.

The change in speed of the output shaft is accomplished by changing the position of the collar assembly *N*, which moves the spline shafts *A* and *B* relative to each other and changes the relative positions of the two eccentrics. By changing the throw of the eccentrics, the oscillations of disk *E* are varied and the amount of movement of the crankshafts is likewise increased or decreased, as is the rotary motion of the planet gears. By moving the collar *N* to one extreme position the two eccentrics are brought exactly opposite each other, thereby giving concentricity, so that disk *E* is stationary and the output

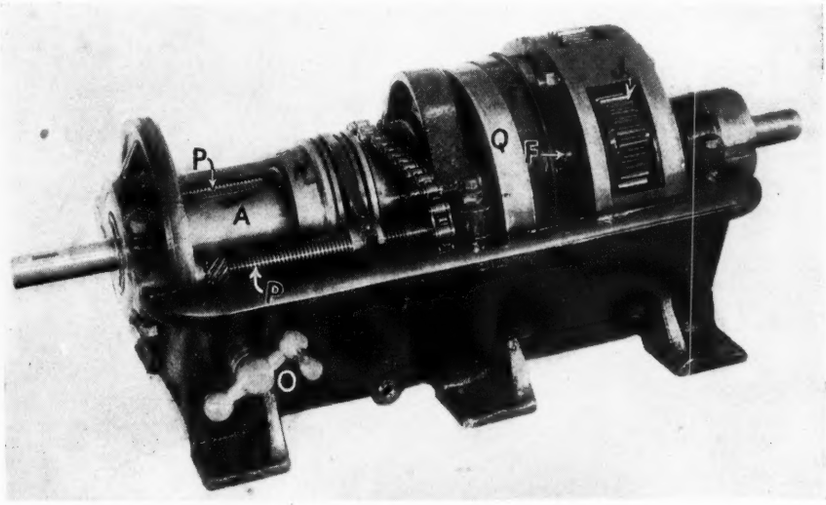


Fig. 21 — Universal Gear, Pitter, infinitely variable-speed transmission can be built for any horsepower. The drive can be in either direction specified and may be equipped with a reversing mechanism. The input speed of a standard unit must not exceed 1,200 r.p.m. The maximum output speed is about 550 r.p.m. and may be decreased in infinite steps to zero with the unit under load

element is at rest. By moving collar *N* to the other extreme the throws of the two eccentrics are added, thereby giving maximum eccentricity and a corresponding motion to the output element for each revolution of the input shaft. Several means may be used to shift collar *N*. It may be done manually from a handwheel or crank, or automatic or remote control may be applied.

A counterweight *Q* is mounted on an eccentric *R* in such a way that at any time it is opposite and equal to the eccentricity of disk *E*, thus balancing the rotating element for every speed change.

These transmissions run in an oil-tight case. In the smaller sizes they are splash-lubricated and in the larger sizes a pressure oil pump is provided.

One of these transmissions, with the top half of the case removed, is shown in Fig. 21. The letters on the parts are the same as in Fig. 20. One of the planet gears can be seen at *J*, the crankshaft at *F*, the free disk at *E* and the counterbalance at *Q*. Collar *N* is shifted along the splined shaft *A* by the crank *O* working through the threaded rods *P* to vary the speed of the output element.

This transmission can be built for any horsepower output and for speed ranges of the output shaft from zero up to about 50 per cent of the input shaft's speed. It is recommended that the input speed of standard units does not exceed 1,200 r.p.m. The highest speed of the output shaft is about 550 r.p.m., and can be decreased by infinite steps to zero while the unit is under full load. Where required, the units can be built so that the output shaft's rotation can be easily reversed while operating under load.

The variable-speed transmission in Figs. 22 and 23 consists of a stationary steel cylindrical casing *D*, the inside of which has the form of a sphere at its equator. The inside surface of the casing is hardened and ground to a true spherical shape on which the rotating element runs. The rotating, or, more strictly, the nutating element *E*, is carried on rollers *R* that run on ball bearings. This nutating element is connected to the output shaft *S'* by a rolling ball universal joint that operates with a constant angular velocity up to a maximum angle of 40 degrees.

A connection between the input shaft *S* and the nutating element is made by a splined shaft *G* connected through a double link *L* to sleeve *K* on a short shaft extension from the nutating element. In the figure, the axis of the input shaft and that of the nutating element are on the same straight line. With this set-up the output element remains stationary when the input shaft is rotated, sleeve *K* simply revolving on its shaft.

The shaft connecting to link *L* is splined to *S*, and it may be moved endwise by the control lever *F*. By moving shaft *G* endwise to the left, link *L* will cause the nutating element *E* to make an angle with the vertical. For example, take a position such as that indicated by axis *BB*. With the nutating element in the position indicated by line *BB* the axis of its shaft would be in the position indicated by line *X*. Assuming that the nutating element is in position *BB*, then when the input shaft has made one-half revolution link *L* will be below the nutating element's shaft and this element will have tipped as far to the right of vertical axis *AA* as it was to the left of it at the beginning of the half revolution. That is, the axis of the nutating element will take the position indicated by line *CC* and the axis of its shaft will be in position *Y*.

On the other half of the revolution the nutating element will swing back to position *BB*. While the nutating element is swinging back and forth across the inner surface of its inclosing case it is also rotating. The speed of rotation of the nutating element compared to

the input shaft's speed depends upon how much the nutating element is tipped from the vertical.

Fig. 24 indicates what takes place as the nutating element moves back and forth across the inner surface of its inclosing case. When the nutating element's angle of displacement from the vertical is small, it has a motion similar to that indicated by line *A, B, C, D*. In moving distances *AE* and *AF* either side of its vertical axis, for one revolution of the input shaft, the nutating element rotates a distance equal to *AD*. If the nutating element is tipped farther away from its vertical position it will describe some such path as that represented by the line *A, B′, C′, D′*. In this case, as the nutating element moves distances *AG* and *AH* either side of its vertical axis it rotates distance *AD′* inside its inclosing case.

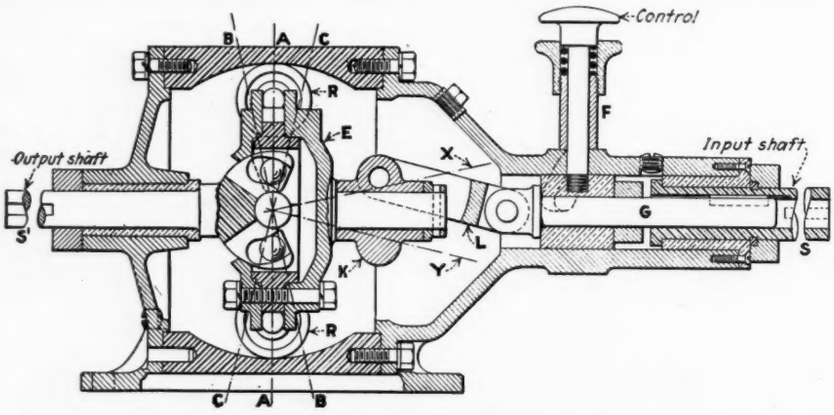
The nutating element will always rotate in the same direction as the input shaft. The ratio of speed change from the input to the output shaft is from 0 to about 0.234 of the input speed. For example, if the input shaft speed is 1,800 r.p.m. the speed of the output shaft can be varied from 0 to 1,800 × 0.234 = 421 r.p.m. Within this range it is possible to obtain any desired speed, even to 10 revolutions per hour, or less.

Another way of considering the transmission's operation is to study it with the nutating element in the neutral position, Fig. 22, and then assume it to be moved 90 deg. from the neutral. In Fig. 23 it is evident that if shaft *G* is turned, sleeve *K* will rotate on the shaft of the nutating element without causing any movement of the output shaft.

Now assume that the nutating element is moved 90 deg. from the vertical: its vertical axis in Fig. 22 becomes parallel with the horizontal. Under this condition the nutating element will have motion only about the horizontal axis, and the output shaft will run at the same speed as the input shaft. If in this position the two shafts have the same speed, and in the neutral position the speed of the output shaft is zero, it is fair to assume that the speed change of the output shaft is gradual, as the nutating element is moved from the vertical to the horizontal position, or vice versa. This change in speed is accomplished by the nutating element traveling in a path on the inside of the inclosing case as explained in Fig. 24.

It is impossible to move the nutating element 90 deg. from its vertical position in Fig. 22. The maximum change is about 40 deg. and with the movement the output shaft's speed will be about 0.234 that of the input shaft, as previously explained.

In Fig. 22 the speed change is made manually by the movement of a lever, but, when required, remote or automatic control may be used. Speed changes can be made under load with little effort on the control lever.



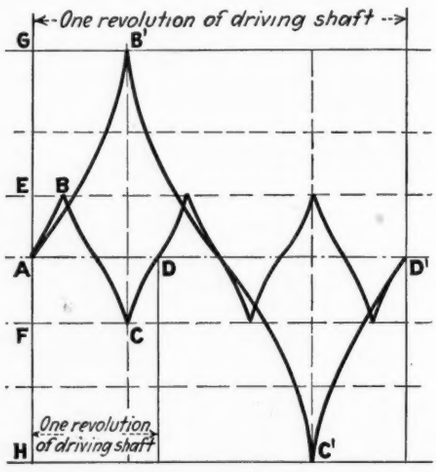


Fig. 24 (Above)—Path of the rotating element *E*, Fig. 22, during one revolution of the input shaft

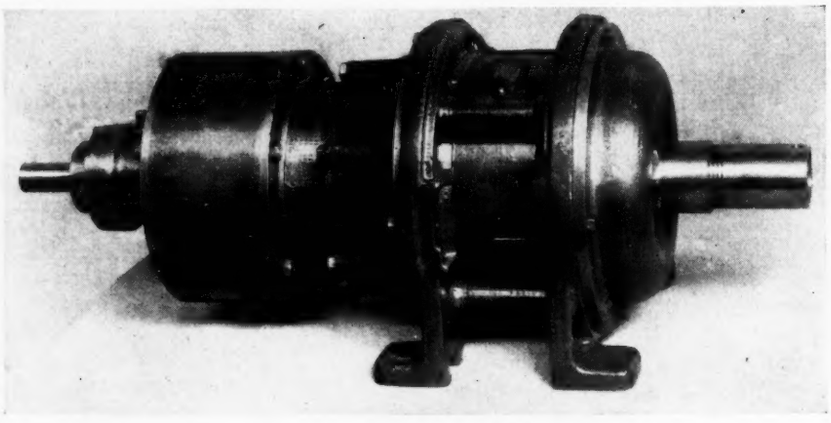


Fig. 22 (Above, Left)—Longitudinal section through a variable-speed transmission of the type connected to the motor, Fig. 23

Fig. 23 (Left)—Weiss variable-speed transmission combined with a motor to form a single unit

The transmission may be had as separate units or in combination with its driving motor, Fig. 23. The maximum input shaft speed for which it is designed is 3,600, and the unit may be had in any capacity.

For assistance in the preparation of this article the author wishes to thank the Columbia Vari-Speed Company, Chicago, Ill.; Stephens-Adamson Mfg. Company, Aurora, Ill.; Driscoll Transmission Corporation, New York City; Universal Gear Corporation, Chicago, Ill.; and the Weiss Engineering Corporation, New York City.

IN THE ARTICLE on variable-speed transmissions, March 10 number, the maximum capacity of Reeves-type transmissions was given as 50 hp. This value is the maximum size of standard equipment. Larger-capacity units may be had in sizes up to 150 hp., designed especially for their applications.—EDITOR.

How to Lay Out a Factor-of-Evaporation Chart

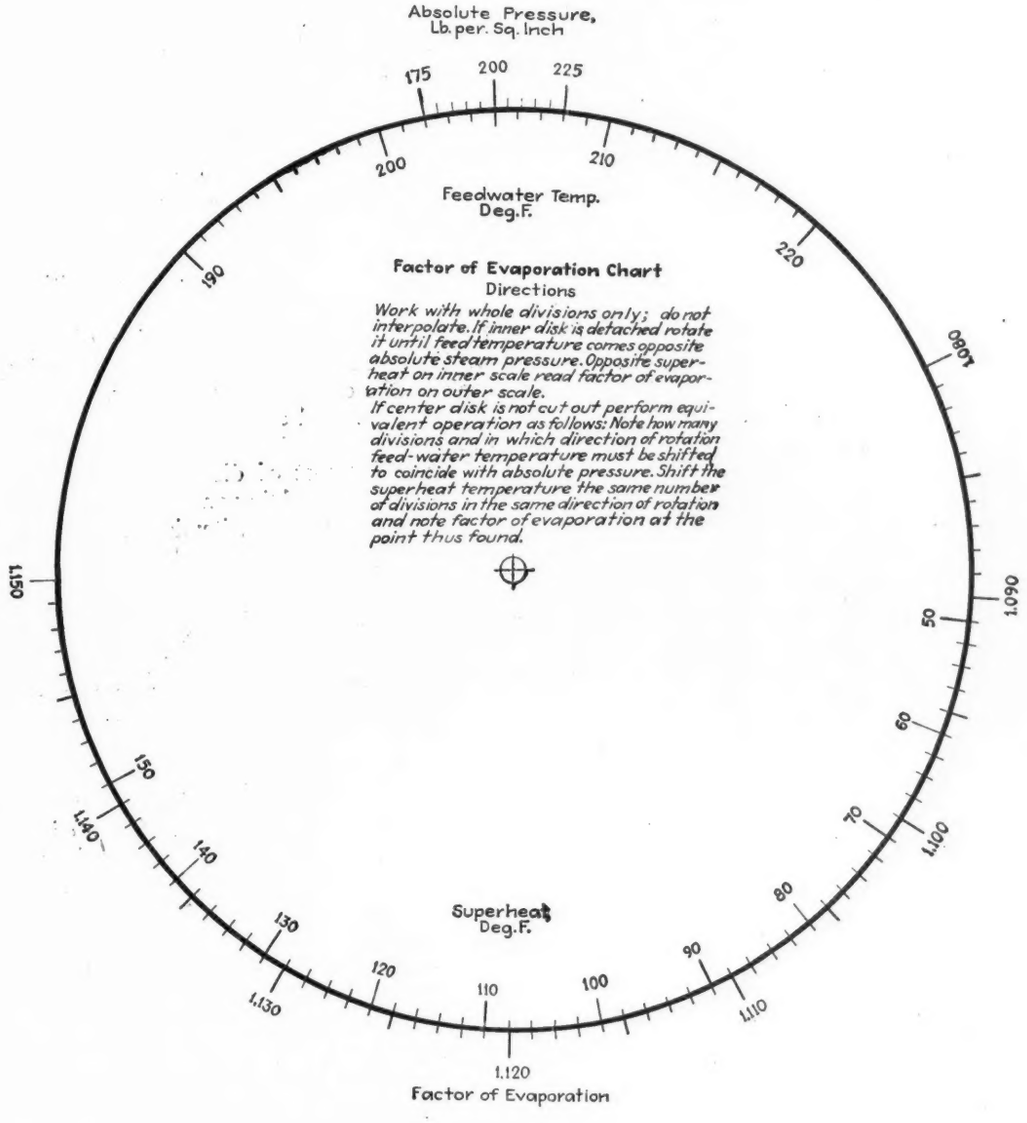
By GORDON R. HAHN

WHEN MANY boiler tests or efficiencies are to be computed, it becomes quite monotonous to figure the factors of evaporation for varying steam pressures, degrees of superheat and feed-water temperatures. A simple device can be constructed or laid out to eliminate such computations.

The following explanation gives the method for making a chart which gives factors of evaporation covering steam pressures between 175 and 225 lb. abs., degrees superheat 50 to 150 F. and feed-water temperatures from 190 to 220 deg. F. By following the same procedure the device may be laid out to suit any steam conditions that may be encountered.

Proceed as follows: Draw a 4-in. circle and mark off equal divisions (say one-tenth inch) on the periphery.[1] Each division equals one B.t.u. at 100 deg. F. superheat and 200 lb. pressure. A change of 5 lb. in the steam pressure changes the B.t.u. content of a pound of steam 0.6 B.t.u. Therefore the 50-lb. change, from 175 to 225 lb., means 6 B.t.u. Lay off the points corresponding to 175 and 225 lb. on the outer edge of the circle opposite two of the divisions (six apart) previously marked off. Divide the space between into an even pressure scale. Lay off the feed-water temperature scale on the inside of the circle at the top. Put the 208 deg. temperature mark on the inside opposite the 225-lb. mark on the outside. Each inside division equals one B.t.u. and is equal to a change in feed temperature of one degree.

Each degree difference in superheat at these conditions means a change in B.t.u. content of a pound of steam of 0.5 B.t.u., since the specific heat is approximately 0.5. Lay off the degrees superheat scale diametrically opposite the feed-water temperature, letting one division equal 2 deg. superheat. If the steam conditions to be considered are considerably different from those mentioned the specific heat will not be 0.5 as


Absolute Pressure, Lb. per. Sq. Inch
175
200
225
200
210
Feedwater Temp. Deg.F.
190
220
Factor of Evaporation Chart
Directions
Work with whole divisions only; do not interpolate. If inner disk is detached rotate it until feed temperature comes opposite absolute steam pressure. Opposite superheat on inner scale read factor of evaporation on outer scale.
If center disk is not cut out perform equivalent operation as follows: Note how many divisions and in which direction of rotation feed-water temperature must be shifted to coincide with absolute pressure. Shift the superheat temperature the same number of divisions in the same direction of rotation and note factor of evaporation at the point thus found.
1.060
1.090
1.150
50
60
70
1.100
150
1.140
140
80
130
90
120
1.130
110
100
1.110
Superheat Deg.F.
1.120
Factor of Evaporation

[1]Chart reproduced has larger circle and larger divisions.

assumed. Steam tables must then be consulted to find out the number of degrees of superheat equal to one B.t.u., and the scale must be marked off accordingly, letting one B.t.u. equal one-tenth inch.

The factor-of-evaporation scale must now be laid out. This requires some calculations. At 225 lb. abs. and 208 deg. feed-water temperature (these points coincide on the chart) and 70 deg. superheat, the factor equals

$$\frac{1{,}244 - (208 - 32)}{970.4} = 1.101$$

For 175 lb. and 202 deg. (these points also coincide) and 150 deg. superheat, the factor equals

$$\frac{1{,}279 - (202 - 32)}{970.4} = 1.141$$

Mark off these points on the outer rim of the circle opposite the superheat temperatures of 70 and 150 deg., respectively, and complete the factor-of-evaporation scale from these points. In this case each division of the superheat scale equals 0.001 on the factor-of-evaporation scale.

This device may be used in two ways. One method is to cut out the inner part, paste the two pieces, outside and circle, on separate pieces of cardboard and pivot the circle so that it will rotate with respect to the outer part. By setting the feed-water temperature to the steam pressure in question, the factor of evaporation will be found under the superheat temperature. The second method requires no cutting and is stated on the chart.

The accuracy of this device, with a 4-in. circle, equals that of a 10-in. slide rule at least. If more accuracy is required the chart must be made larger or a smaller range must be considered. If close accuracy is not required, a greater scale may be used or the chart may be made to cover a larger variation in steam conditions.

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Hydraulic Turbine Repaired By Electric Welding

By C. R. REID

Assistant General Superintendent
Shawinigan Water & Power Company

A VERTICAL-SHAFT Francis-type cast-iron runner 12 ft. in diameter and weighing 70,000 lb. failed. The unit was rated at 20,000 hp. at 120 r.p.m. under an 80-ft. head. The runner broke down while the unit was running at normal speed but without load. Apparently, one of the runner buckets had been cracked through at the upper end near the hub for some time. It finally broke off near the lower end and was thrown outward by centrifugal force, striking a guide vane and being broken in several pieces. Part of the trailing edge was broken off the guide vane, as well as the intake edge from two other runner buckets. In addition, these runner buckets were cracked through at the top near the hub, and several others had cracks starting from their inside or trailing edge and running parallel to the hub from 6 to 10 inches.

The turbine was dismantled and the runner and shaft were set up in a vertical position on the power house floor, as in Fig. 2 on the next page. Patterns were made to replace the missing parts in cast steel. In order to hold the filler parts to the intake edge of the two buckets, they were cast with ears extending back and dove-tailing into the cast iron, grooves being chipped out to receive them. Cast steel was used in preference to cast iron on account of the greater ease with which it can be welded.

The cracks were veed out as shown at *A*, Fig. 1. All cast-iron surfaces to be welded were drilled, tapped and studded with steel studs from $\frac{3}{8}$ to $1\frac{1}{4}$ in. in diameter. In the thin parts of the bucket and in the intervals between the large studs $\frac{1}{4}$-in. drive screws were used. The welding was done by one welder and a helper working 8 hr. per day. Welding operations were not carried on at one point long enough to heat up the surrounding metal. The chipping and placing of the studs was completed in three weeks and the welding in an additional four weeks.

The replacement bucket weighed 2,100 lb. In order to handle it with the crane, eyes were welded on to the intake edge. Some difficulty was experienced in placing the bucket and maintaining it in position for welding, but alignment of the completed job was entirely satisfactory. Fig. 3 shows a section of the runner after welding. The bucket in the center is of cast steel and replaces the one broken out in Fig. 1. On the right, the bucket has a steel edge dove-tailed into the parent metal at *A*.

The entire cost of dismantling the unit, making the repair and reassembling amounted to $2,274. The repair job alone cost $953.62, itemized in the table. Approximately 200 lb. of welding rod was used.

Patterns, 3	$183.95
Steel castings, 3	198.90
1, 35 lb. at $14 per cwt.	
1, 20 lb. at $17.60 per cwt.	
1, 2,130 lb. at $8.85 per cwt.	
Labor—Oct. 10 to Nov. 20	375.12
Railroad fare and board for 2 men	59.40
Welding rod, studs and miscellaneous material	72.25
Taps, drills, grinding wheels	20.00
Traveling expenses of master mechanic	44.00
Total	$953.62

After six weeks' operation the runner showed no sign of erosion on the paint. Some of the welds have separated from the cast iron to a slight degree on the discharge side of the bucket next to the hub. This is the place where cracking started on a number of buckets both on this runner and on other runners of the same pattern. However, these checks do not appear to be extending, and it is believed that the studding will furnish ample strength to hold the parts in place.

The unit was out of service a total of ten weeks. It would have been possible to have put on a larger crew and make the repair in less time, but the unit was not particularly in demand at the time and the work was not rushed. A new runner was ordered soon after the breakdown, but seven months was required for delivery. It was considered worth while to repair the damaged runner even if the repair lasted only until the new runner was on hand. It is now believed that the repaired runner may be continued in operation indefinitely.

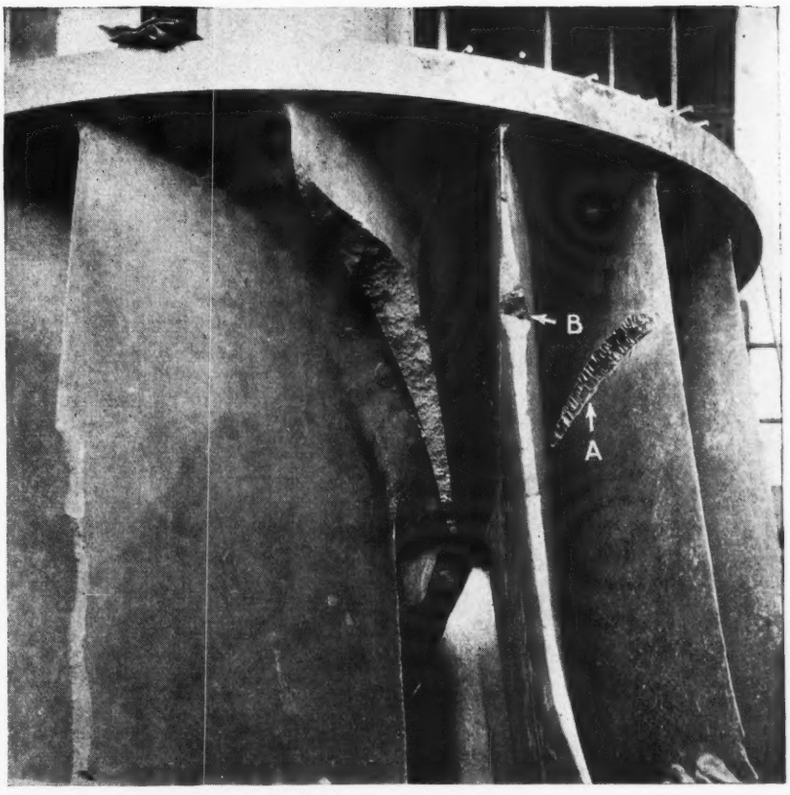


Fig. 1 (Right)—Section of the turbine that was damaged. The bucket on the left had its intake edge broken off, the center bucket was broken out entirely, the next bucket to the right had its intake edge broken off and was cracked through at *B*, and the next bucket was cracked through at *A*. The method of chipping the cracks before welding is shown at *A*

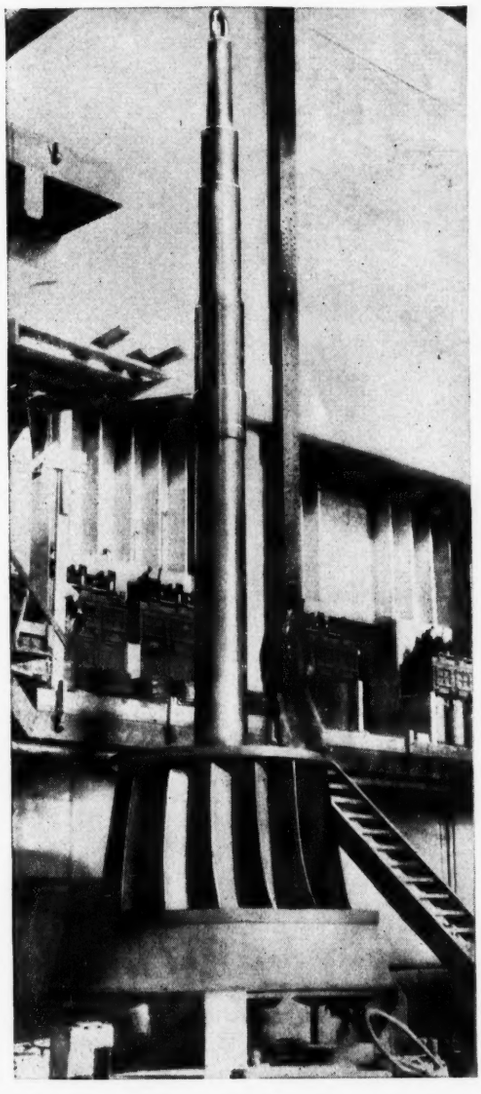


Fig. 2 (Above)—Type of runner on which the welding was done

Fig. 3 (Right)—The bucket in the center is of steel and replaces the one shown broken out in Fig. 1. On the right the bucket has a steel edge dove-tailed into the parent metal at *A*

Fuel Pumps for Solid-Injection Diesels

The fuel pump is the heart of the solid-injection diesel and the behavior of the engine depends far more upon the pump than in case of the air-injection diesel. The speeding up of engines has introduced new problems of fuel pumping, to overcome which engineers have evolved new mechanisms, most of them, however, following basic designs used on the earliest engines.

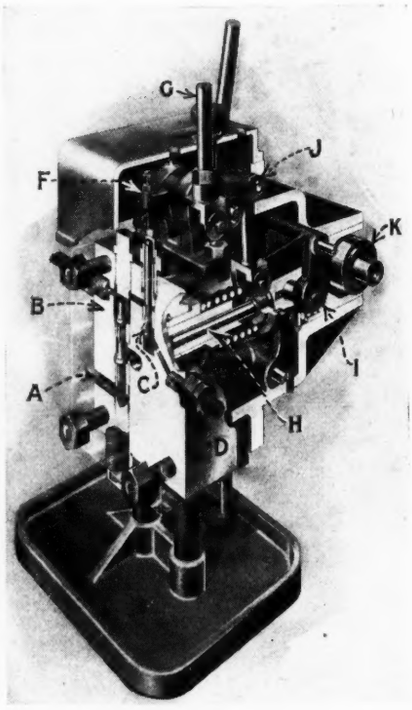


Fig. 1—Pump used on new Ingersoll-Rand diesel

AS LONG as diesel engines employed air for fuel-injection purposes, the fuel pump was not conceded to be a problem, for its duty was merely to meter a fuel charge and deliver to the spray valve against a not excessive oil pressure.

The hot-bulb oil engine, the forerunner of the present-day solid-injection diesel, operated with low pressures, and as the oil was injected during the compression stroke no great degree of timing accuracy was necessary. The pump, then, was a simple displacement apparatus, made up of a case-hardened plunger, fibrously packed against leakage and provided with valves of no great workmanship. Metering was obtained through allocation of the pump plunger stroke. A simple pump of this character

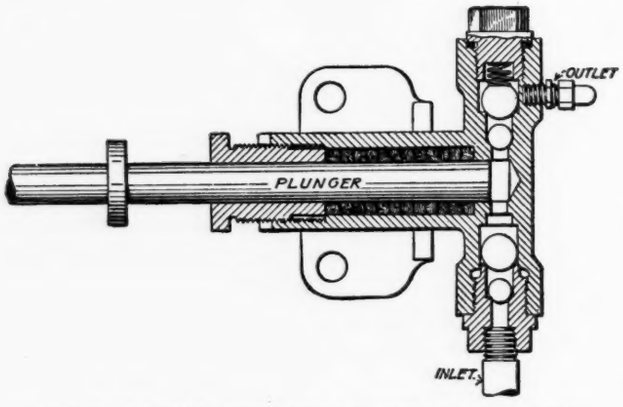


Fig. 2—A packed plunger found on many hot-bulb engines

is shown in Fig. 2. The fuel entered the cylinder through a single check-valve orifice, and oil dribbling, after the plunger ended its stroke, was expected.

With the development of the modern solid-injection diesel such simple pumps utterly fail to meet the requirements. To properly atomize the oil spray and so insure good combustion the velocity of the oil spray must be high, around 200 to 300 ft. per second. To give this the pump discharge pressure must be high, ranging from 1,500 to 10,000 lb., depending upon the cylinders' combustion chamber design. To obtain satisfactory ignition and combustion fuel must enter the cylinder before dead center, but not too early to produce pre-ignition. The timing of the injection, consequently, is of prime importance, and the metering of the change, which in small high-speed diesels is minute, must be satisfactory. Pump designs must therefore include the elements of strength and accuracy.

The metering mechanism must respond to the governor without sluggishness, and at the same time the plunger and control valve reactions to the high discharge pressure must not be transmitted to the governor. The parts must be built to withstand the hard service and yet be accessible and not excessive in replacement cost. In many respects the problem is similar to the construction of a large punch press with parts as accurate as the movement of a fine watch.

Surprisingly, the pumps found on most modern diesels meet the requirements—some better than others, of course, and many with minor defects. These defects, while not rendering them unsatisfactory, may make them suitable only for engines of a narrow speed range of a particular combustion-cavity design.

Since the delivery of oil is the basic purpose of a fuel pump, the various designs may be divided into two classes, those giving a constant pump delivery velocity and those giving a variable oil delivery velocity.

Delivery velocity is used in preference to injection velocity, for there are factors that prevent a uniform injection of the oil into the cylinder even though the

velocity at which the oil leaves the pump is constant. For example, under high pressures, such as exist with many pumps, the oil must leave the pump at pressures over 5,000 lb. per square inch, and the compressibility of the fuel may be as much as 1 per cent. If the fuel charge handled at one stroke of the pump is 1 per cent of the volume of the discharge piping and spray valve cavity, then this oil in the piping will compress an amount equal to the volume of the delivered charge, so no oil will enter the engine. Regardless of the oil volume of the piping, it is obvious that the effect of this compression of the volume will be more pronounced at light loads than at heavy if the spray valve is spring-loaded. In addition, the expansion of the piping walls has a like effect.

The inertia of the volume of oil in the connecting piping also delays the point of injection. The lag in delivery is quite evident in some engines using long oil lines. In one engine the injection, as shown by indicator diagrams, is 7 deg. ahead of piston's dead center, while the pump starts delivering at 19 deg. The inertia of the oil column is so great that the piping expands when the plunger starts its delivery, and after delivery is ended the contraction of the piping causes the injection to continue for several crank-degrees.

The constant discharge velocity may be obtained with a pump having a fixed-stroke plunger and a controlled bypass, or spill, valve or by a variable-stroke pump. Pumps with bypass control are of the general type shown in Fig. 3. In the sketch to the left the bypass remains closed during the early part of the inward stroke of the plunger *B* and oil is forced out through the discharge valve *A* until the collar *D* lifts the lever *L* and opens the bypass valve *E*. It will be noted that the start of the discharge to the spray valve is always at the same crank position.

Typical examples of this basic design are shown in Fig. 1 and Figs. 4 to 8. In addition, Fig. 11 employs the same principle but makes use of the pump plunger as the bypass valve: the plunger, which makes a fixed

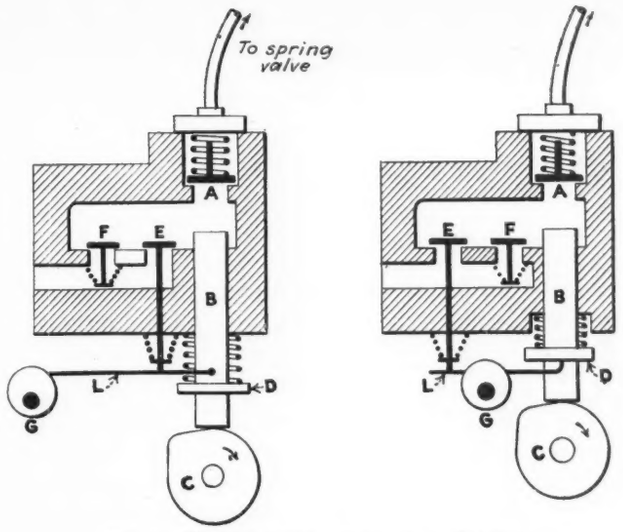


Fig. 3—The two basic bypass pump designs

stroke, has a helical groove milled in its surface in connection with slot *C*. The plunger reciprocates in a bushing *B*, containing two drilled openings through which the oil enters the pump cavity when the ports are uncovered by the plunger. The plunger has a slot at its lower end through which a key engages with a movable collar *E*. The latter has a gear *D* milled on it that meshes with a rack on the governor rod. The governor then controls the fuel charge by moving the gear *D*, which, in turn, rotates the collar *E* and the plunger. As a consequence the helical groove on the plunger coincides with the right-hand suction port and all the oil above the plunger escapes down the vertical slot and the helical groove into the right-hand suction port. On light loads the plunger is turned so that early in the plunger discharge stroke the helical groove frees the oil, and on full load the helix is so turned that the relief comes late.

Below the pump drawing in Fig. 11 are shown the

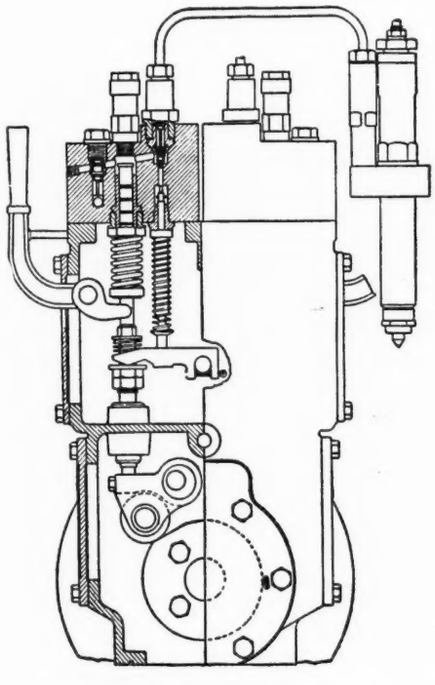


Fig. 4—Pump of the Fulton-Foos high speed engine

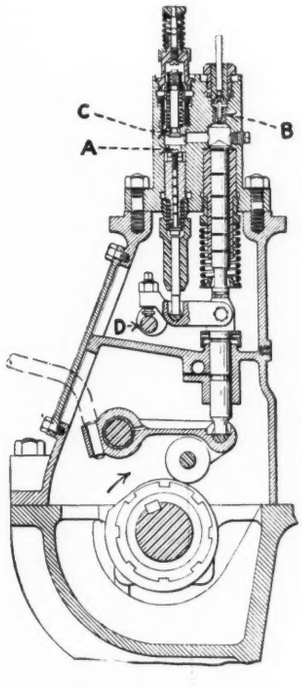


Fig. 5—The Chicago Pneumatic Tool diesel has this pump

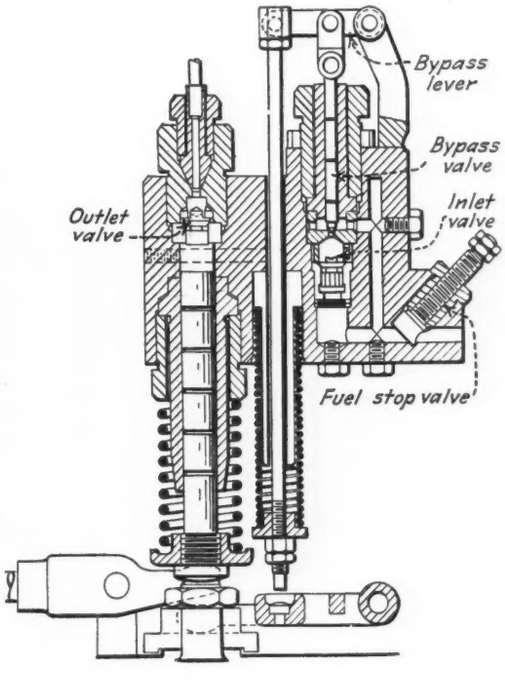


Fig. 6—Pump of the Otto-Superior diesel

positions *A* and *B* of the helix for the start and end of injection at full load, the positions *C* and *D* at half load, and the position *E* of the plunger, where the control is put into the stop position, at which time the vertical slot is in line with the suction port, thereby affording free passage at all positions of the plunger. This pump is largely used on high-speed engines, having been adopted by several engine builders.

It will be noticed that some of these pumps have the bypass valve in the pump cavity between the plunger and the discharge. As soon as the bypass opens the pressure in the pump body drops and the discharge valve closes. But the oil line to the nozzle is filled with oil at a pressure depending upon the promptness with which the discharge valve closes as well as upon the action of the pipe itself.

It is not difficult to picture the line filled with oil at a pressure not much below the usual discharge pressure, which is more or less maintained by the contraction of the oil piping. Evidently, if there is no great resistance at the spray nozzle, the oil will continue to flow out after the pump has ceased to discharge fuel into the line. If the spray valve is spring-loaded, so that a high pump pressure must be created before the spray valve will open, then at a small drop in the line pressure the spring-loaded valve will snap shut and dribbling will be avoided. On the other hand, a nozzle with a lightly loaded check valve offers no such closing action, and oil will continue to flow for some time. It follows that unless some way is provided to free the discharge line of its pressure when the bypass opens, a heavily loaded differential needle type spray valve will give a greater freedom from dribbling.

Other designers provide for the pressure release by placing the bypass between the discharge valve and the delivery oil line. As a consequence, when the bypass opens, the pressure in the entire line to the spray valve drops to that of the pump suction.

In Fig. 1 the bypass valve *C* is connected by links *F* and *J* and bell crank *I* to the crosshead of the plunger *H*. The suction line is at *A* and the discharge valve is at *B*. It will be seen that the bypass valve is in direct communication with the discharge line, relieving the entire line of pressure.

A pump for high-speed engines is shown in Fig. 7. Here the bypass valve is between the discharge valve and the discharge line to the spray nozzle. Two controls *A* and *B* are embodied in this design. The start of the plunger's movement is controlled by the shifting of lever *B*, which by moving horizontally causes its rollers to contact with the cam early or late, as the case may be. However, the lateral movement is so small that the total plunger stroke is but slightly affected, and there is always an excess plunger travel in any event.

The time of opening of the bypass is controlled by the rocker *A*, whose inner end is given a curvature where it contacts with the plunger roller, for the purpose of compensating for the alteration in travel brought about by the lateral movement of the timing lever. The eccentric fulcrums of the two arms are controlled by the governor.

The pump in Fig. 8 has the bypass between two discharge valves, to prevent emptying of the delivery line when the bypass opens. This pump is employed with open, or check-valve, nozzles, which seemingly is in contradiction to the statement that pipe line relief is desirable with such nozzles.

These pumps with discharge pressure relief may be, and generally are, used in connection with the so-called "open nozzles," which are essentially nozzles provided with light check valves, the checks being added to prevent back flow of the combustion gases into the fuel lines.

The basic design shown at the right in Fig. 3 has been adopted for a few different makes of engines. In Figs. 9 and 10 are shown two pumps in which the oil flows back through the open suction valve until the valve rocker arm disengages from the valve stem and permits closure. The injection period is then the second part of the plunger stroke, rather than the early part.

In Fig. 10, a diagrammatical outline of a pump, the plunger strikes a relief valve at the end of its stroke, to relieve the pump pressure. This pump, in contradistinction to all others so far discussed, employs two cams, and the governor controls the amount of fuel injected

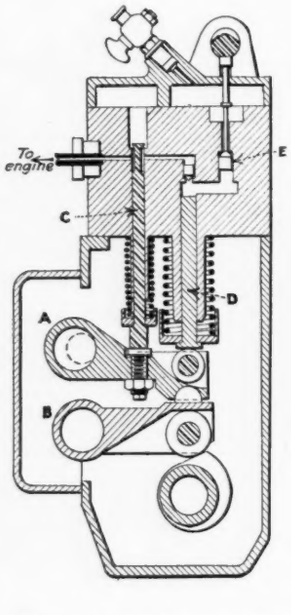


Fig. 7—The Buda high-speed diesel's pump

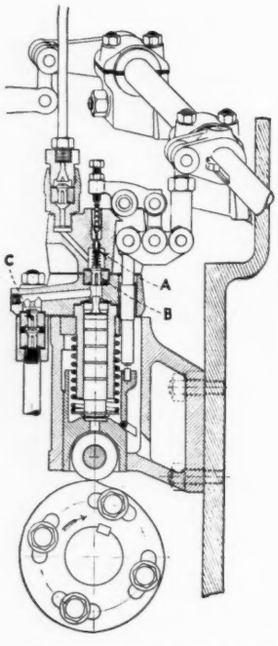


Fig. 8—Pump of the De La Vergne engine

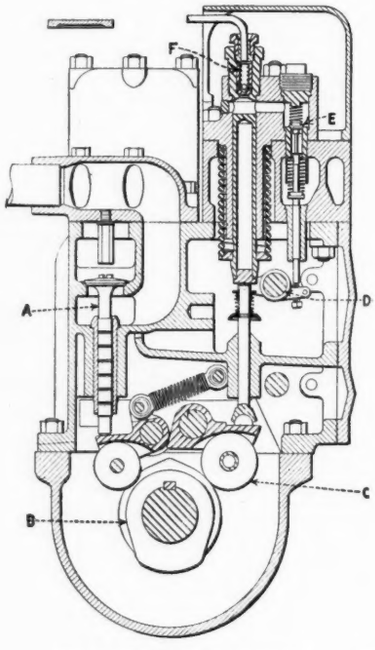


Fig. 9—Fairbanks, Morse & Company employ this pump

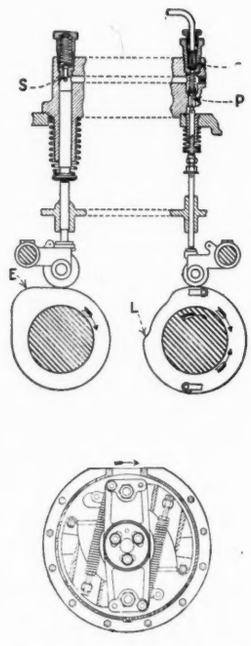


Fig. 10—Pump on old Fairbanks, Morse & Company engines

into the cylinder by shifting the suction valve cam so that its low, or "closing," portion comes under the valve stem at the proper point in the plunger's stroke to limit the fuel injection to the correct value. As shown in Fig. 10, the suction valve is open and the pump plunger is just starting on its discharge stroke. At the bottom is shown the governor, which changes the relation of the pump and suction valve cams, both of which are on the same shaft.

At present practically all pump barrels or bushings are of hardened and ground steel; in some instances

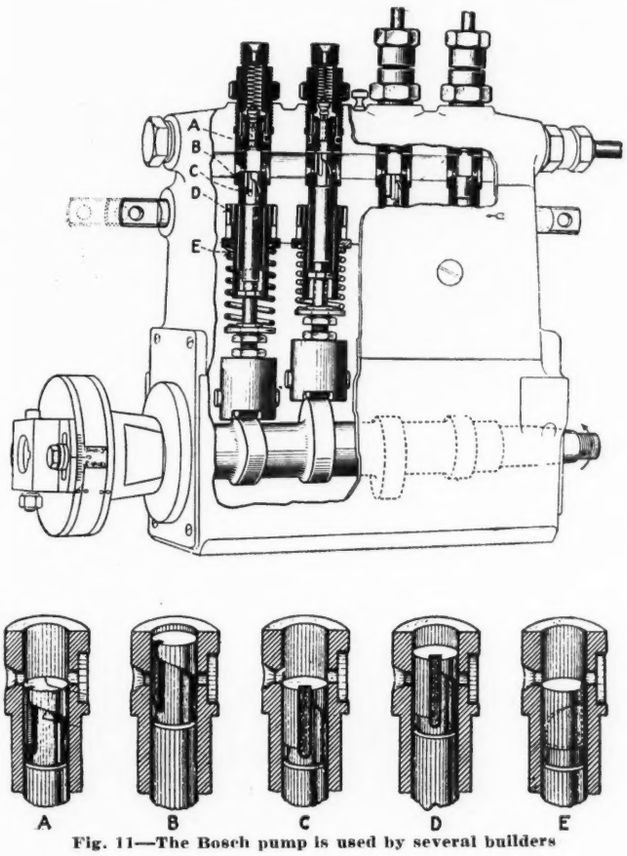


Fig. 11—The Bosch pump is used by several builders

Nitralloy is used. Plungers are likewise hardened, and the final fitting is by a tapping process, no packing being employed.

At times an operator finds that the plunger scores, small thin flakes of the metal leaving the surface. Usually the bushing is also damaged, which calls for the renewal of both parts. The difficulty seems to be traceable mainly to the kind of fuel handled. If the oil is a light distillate or kerosene, with little lubricating effect, the plunger dries. Heavier fuels, which have greater lubricating properties, seldom cause trouble.

▼

IN THE GENERATION of electric energy so much depends upon the human element that the greatest care must be exercised to select only competent men. Unless high standards are adhered to in their selection and training, avoidable interruptions to service are sure to occur. It is a fact that after a few years many operating positions become irksome and monotonous. This is not so true of maintenance and construction work, because of its variety. Operating men should, therefore, be given the opportunity of transferring to more agreeable employment.—RALPH B. DONALD.

Refrigeration Essential To Baking Procesess

By F. P. SIEBEL

Manager
Siebel Institute of Technology

APPLICATION of refrigeration to baking is now more extensive than ever before, but the limit has by no means been reached. The time has come where it is essential for the refrigerating engineer to know more about the baker's problems, so that he can act intelligently in planning a refrigeration system that will adequately meet the latter's requirements.

It has been estimated that the heat introduced by the materials alone at incorrect temperatures amounts to approximately 5,000 B.t.u. per barrel of bread dough, assuming that the initial temperatures of the ingredients are of average value. The flour, for example, may enter at from 75 deg. F. to 80 deg. F., water as taken from the tap will run from 50 deg. F. to 65 deg. F. and sugar and shortening will have a temperature of 80 deg. F. It will be seen that the average entering temperature of these ingredients is very nearly the desired temperature of the dough, and it does not take much added heat to increase the dough's temperature to a dangerous point.

The heat of hydration, that resulting from the addition of water to the flour and similar to the heat produced by adding water to quicklime, must be taken care of. It amounts to about 6.5 B.t.u. per pound of flour. This may seem inconsequential at first glance, yet it amounts to about half a ton of refrigeration in a 100-lb. dough batch, in addition to the heat from other sources.

The frictional heat produced by the agitation of the dough is also a problem. On the well known basis that every horsepower produces 42.42 B.t.u. of heat per minute, the total is comparatively easy to compute. If 5 hp. is being expended upon the dough per minute, the heat produced is equal to $5 \times 42.42 = 212.1$ B.t.u. If the mixing time is twelve minutes, the heat produced is 2,545.2 B.t.u., or enough to raise 2,545.2 lb. of water 1 deg. F.

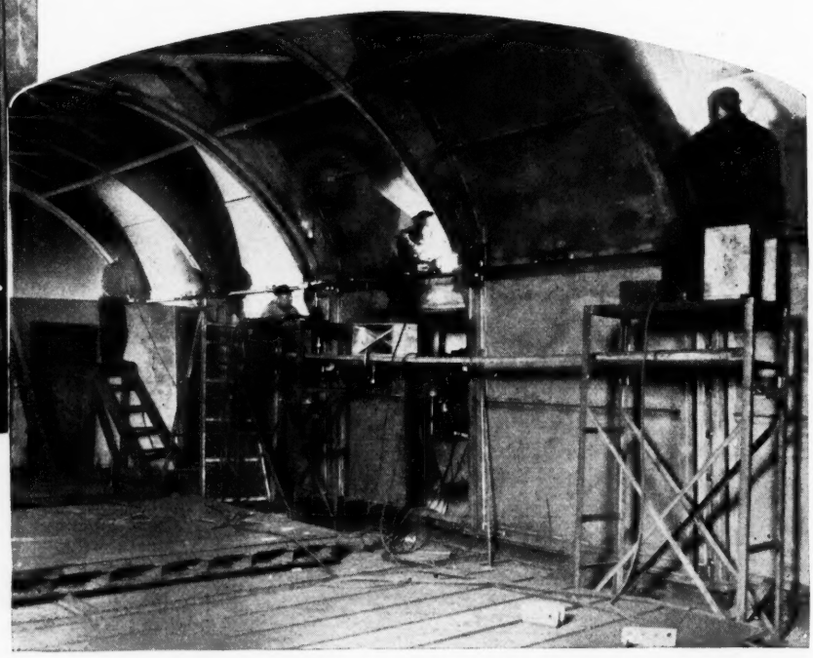
Computing the refrigeration requirements in terms of tons of refrigeration, or the melting equivalent of 2,000 lb. of ice per 24 hr., this standard rating corresponds to 12,000 B.t.u. per hour, or 200 B.t.u. per minute. To supply all this refrigeration directly by the condensing unit would require equipment of a size all out of proportion, because all of the refrigeration would necessarily have to be applied in the very short time of mixing, which averages about ten minutes. To avoid an excessively large compressor a considerable refrigeration storage capacity must be provided,

Higher temperature and humidity accelerate fermentation, while under opposite conditions fermentation is retarded. If the humidity is too low, the dough crusts, because the water is evaporated from the surface of the dough. In addition to the resulting loss in weight, the effects are also manifested in the finished product as hard lumps throughout its interior. To insure best results the temperature of the fermenting room should be between 78 deg. F. and 82 deg. F., while the relative humidity should be about 75 per cent.

[1]Extracts from an address delivered at Chicago Chapter No. 1 of the National Association of Practical Refrigeration Engineers, Engineering Building, Chicago, Ill., Jan. 8.

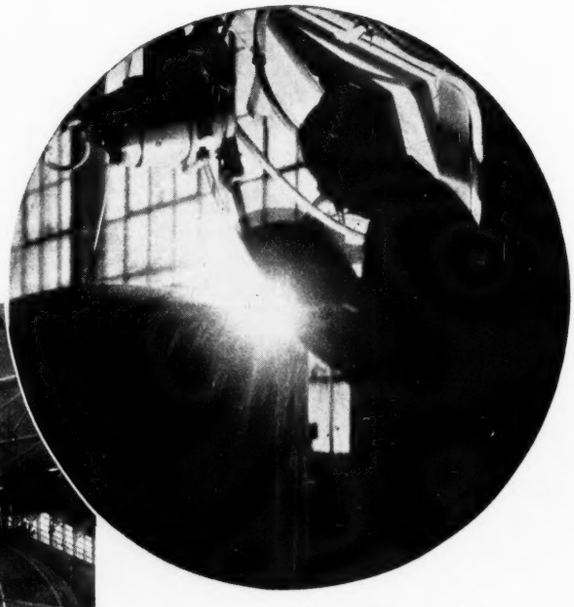
A NEW STUNT in SUBSTATION HOUSING

Above — Doors and mountings, rigidly braced for smooth action and tightness, are fabricated entirely by arc welding



Above—Welders at work in substation section. Note special design of roof girders

WITH THE aid of arc welding, Westinghouse is building outdoor substations indoors. Three of these, arc-welded throughout and unique in design and construction, were recently completed at the East Pittsburgh plant. Each is 65 ft. long, 25 ft. wide and 15 ft. high, and will house a 21,400-kva. frequency changer, the structure weighing approximately 55 tons. For shipment each substation was disassembled into five lower and eight upper sections.



Above—Welder at work on a tank in the Westinghouse shops

Left—Substation completely assembled in shop. Compartments built into each end of the housing contain air filters

...RIGHT OUT OF THE PLANT...

Simple Heating System Control

THE ACCOMPANYING sketch shows an inexpensive automatic control of a heating system providing a maximum and a minimum flow of steam through the same valve, a three-way double-seated, double-disked diaphragm valve, one flow supplementing the other as called for by the room thermostat.

The key-room thermostat, upon contacting and breaking contact, according to the room temperature, admits and relieves the diaphragm valve of air, which, in turn, seats the disk on one or the other seat for the maximum or minimum flow of steam.

Two orifice plates placed as shown meter the flow of steam and are inserted inside of bolt holes of the pipe flanges.

With a fairly accurate layout, in cold weather the maximum flow is on most of the time and in moderate weather the minimum flow is on most of the time if the plant conditions require it that way. The minimum flow may be taken as that required to assure perfect circulation in mild weather, or it may be the flow of steam normally used in the heating season, and during the mild weather the source of supply may be throttled, making the control semi-automatic.

Considerable economy may be effected by this means of control when a studied application is made of its tapering action, especially in a vacuum-return-line system.

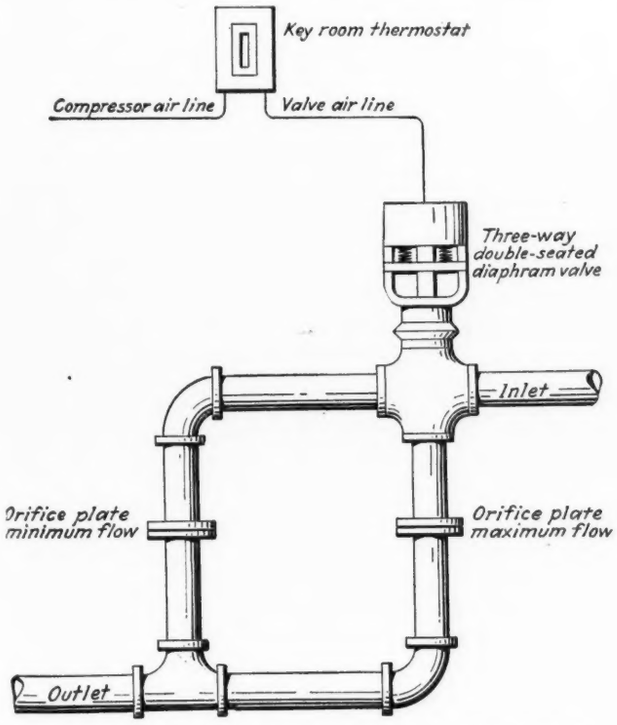
At maximum flow the need of steam is greatest, and the pressure differential and the steam flow are greatest; but when the system fills with steam this pressure differential and flow decrease.

At minimum flow the need of steam is least, and the pressure differential across the orifice plate is least; but when the system empties of pressure steam and a vacuum approaches, the pressure differential and the flow increase.

The orifice plates should be inserted as shown, so that the maximum flow of steam will be available should the air supply fail.

WILLIAM ANDERSON.

Brooklyn, N. Y.



Arrangement of piping for simple heating system control

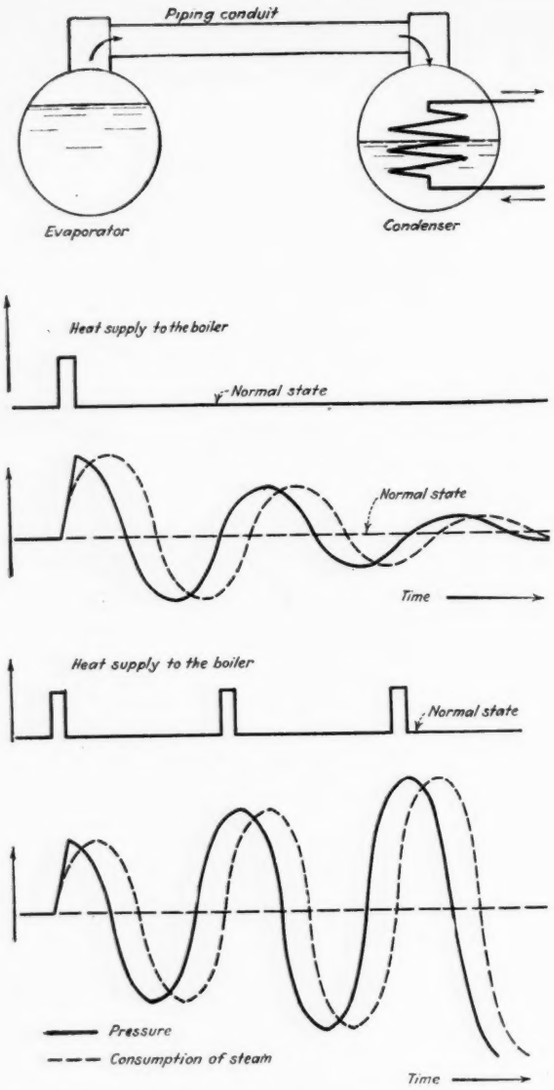
Oscillations of Steam Flow Cause Water Hammer in Evaporator System

IN A certain plant the observation was made that an evaporator caused water hammer at periodic intervals. Great quantities of the solution were entrained by the steam and were carried into the condenser. The damage was considerable. The products of distillation were always mixed with the solution, and it was necessary to renew the distillation repeatedly. But the result was never satisfactory. Different remedies were tried (for instance, the stoking of the fire was diminished), but the water-hammer repeated. Finally it was necessary to remove the evaporator and install a smaller one.

The engineers of the plant recognized that the cause of the water-hammer was oscillations of the steam, but the cause of the oscillations could not be found. Periodic water-hammer has also been observed in steam boilers and the cause would seem to be the same.

In the following the cause of the oscillations is explained in a rather simple way.

The supply of heat to the boiler is supposed to be uniform. For some reason the stoking is forced for a short time, causing a rise of pressure in the boiler. The regular steam consumption will be disturbed, because the quantity of steam flowing from the evaporator to the condenser through the piping is proportional to the difference in pressure between the evaporator and the condenser. As the pressure in the condenser is constant, the rise of pressure in the evaporator causes an increase in the consumption of steam. In the next moment the supply of heat to the boiler will again be normal, but the



Diagrammatic layout of evaporator connections and oscillations in the pressure and consumption of the steam supplied to the evaporator

outflow of steam will have increased above the normal capacity of the evaporator. As the normal heat supply to the boiler will not be enough to produce this excess of steam at the normal pressure, the pressure in the evaporator will fall below normal. The steam flowing in the piping conduit will therefore be lessened, and the steam consumption, being dependent on the pressure, will soon diminish and finally drop below normal. The pressure of the steam will tend to rise again as long as the steam consumption is less than normal. Since the heat supply to the boiler has not changed, the pressure rise will cause another acceleration of the outflowing steam and the cycle will be repeated. I have developed this subject mathematically and have found the rhythm of oscillation of the system, boiler plus piping conduit, dependent on the water space, on the length and width of the piping conduit and also on the pressure in the evaporator. (Published: *Zeitschrift für technische Physik*, December, 1930.)

Where the friction of the steam in the piping conduit is great and new fluctuations in the heat supply to the boiler do not occur, the oscillation of pressure and steam consumption will soon become small.

But if the heat supply to the boiler fluctuates approximately in the same rhythm as the rhythm of the system, evaporator plus piping conduit, the oscillations will become great. The whole contents of the evaporator will begin to foam and to boil and great quantities of water will be carried along by the steam into the piping conduit. Heavy water-hammer will result.

Darmstadt, Germany. DIPL. MG. ROMAN SELIKIN.

Does Wetting Coal Improve Combustion?

THE LETTER by Charles G. Forbes in Dec. 16, 1930, number entitled "Does Wetting Coal Improve Combustion?" brings to mind a similar experience of my own.

While working on the design of small underfeed stokers we had one installation where very fine coal was used. In fact, the coal consisted mainly of yard sweepings and dust. We found that wetting this coal greatly improved combustion. I offer the following explanation.

When the coal was wetted the particles of fine dust, through the cohesive effect of the moisture, formed larger particles, thus allowing larger air spaces between these particles. Upon observation I found that with the dry dust underfire air was forced through the fire bed only at the retort sides, no air coming through the center of the fire. But when the coal was wetted down air was forced through the fire bed almost uniformly over the whole surface.

As to the fact that the coal did not clinker so badly, it is my opinion that the water is converted to superheated steam and, in passing through the fire, cuts down the tendency to clinker in the same way as steam used to stop clinkering and slagging at the sides of the grate against the furnace wall. I do not think the water is broken up into oxygen and hydrogen, as a boiler furnace does not offer very good conditions for this decomposition.

R. H. BARTH.

Pulaski, Va.

PUTTING water on dirty coal agglomerates the dust particles and in doing so reduces the resistance of the fuel bed. This allows more air to pass, increasing the rate of combustion. An increase in the combustion rate gives a higher furnace temperature. The better mixture of air and carbon facilitated by the decreased resistance of the fuel bed and the agglomeration of the dust particles gives combustion with less smoke. The moisture added also retards the distillation of volatile matter, which reduces smoke, and this is likely responsible for the coal's not coking into such hard lumps.

Messrs. Haslam and Russell in "Fuels and Their Combustion" explain that a moisture of 5 per cent or less is an advantage in speeding up the CO combustion rate. Above that, however, it is a detriment. That would also increase the furnace temperature and decrease smoke.

The presence of larger quantities of moisture acts to lessen the concentration of the reacting gases, which retards combustion and reduces the furnace temperature.

Mr. Forbes questions the fact that the moisture is superheated. All moisture entering the furnace, whether contained in or combined with the coal or entering with the air and the hydrogen in the coal, must first be heated to the temperature of boiling water at the furnace pressure met with. It is then changed to steam at the same pressure. As steam it is superheated to the temperature

of the escaping gases. These three functions all absorb heat from the coal, which goes up the stack as a loss.

It appears that the gain obtained through less fuel bed resistance and a better mixture of air overbalances the disadvantages that accompany the wetting down of coal. The real gain would be shown in the evaporation results. I should be interested to know the results of tests run by Mr. Forbes with wet and dry coals.

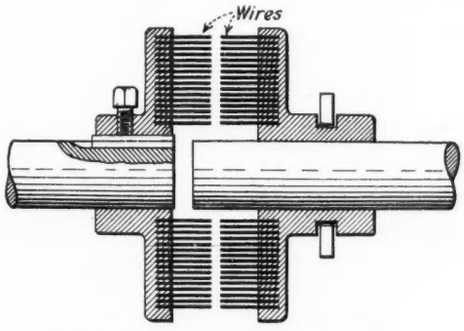
Keyport, N. J. GEO. B. LONGSTREET.

THE benefits of wetting coal to improve combustion apply only to furnaces using natural draft. Coal of the pea and slack variety lies compactly on the grates, making it difficult for enough air to pass through for proper combustion. When wet coal is used steam is generated in the fuel bed. This steam, in passing out, leaves the bed in a porous condition, allowing enough air to pass through for better combustion. Where forced draft is used wetting down is not necessary.

Louisville, Ky. JOS. L. BROWN.

Novel Clutch Design

READING the description of the Pulvis Clutch in the Jan. 27 number of *Power,* I am prompted to write concerning a novel clutch I saw in operation in the Scottish Cooperative Society's Flour Mills, near Glasgow, some years ago. The fixed and sliding elements of this clutch consisted of flanges with numerous



Clutch with wires as flexing element

wires of equal lengths imbedded in their faces somewhat as shown by the sketch. This clutch worked in a satisfactory manner, giving the gradually accelerated starting torque required by the mill equipment to which it was attached.

J. R. FORTUNE,
Manager Heating Division,
Saginaw, Mich. The Wickes Boiler Co.

Salt Water's Energy

AN EDITORIAL in *Power,* Jan. 20, discussed a proposal made by M. C. Raveau, that power be produced by evaporating water and condensing the vapor (after it has passed a turbine) in a salt solution of the same temperature as the evaporated water. This is possible, as you explain, because the solution has a higher boiling point than the pure water. But there is no explanation of the paradox that energy is produced without a fall of temperature being present, neither is the source of energy indicated.

Permit me to try an explanation. The source of energy is the solution heat of the salt water. This energy was taken from the surroundings when the solutions were formed, perhaps millions of years ago. At the same time there must have been a difference of temperature between the water and its surroundings, otherwise the transition of heat could not have been possible.

Budapest, Hungary. STARK LIPOT.

Repairing a Fractured Valve Chest Cover

SOME TIME AGO a bad fracture occurred in a valve chest cover on a reciprocating engine. The crack passed through a stud hole and extended for a distance of about nine inches in a practically straight line.

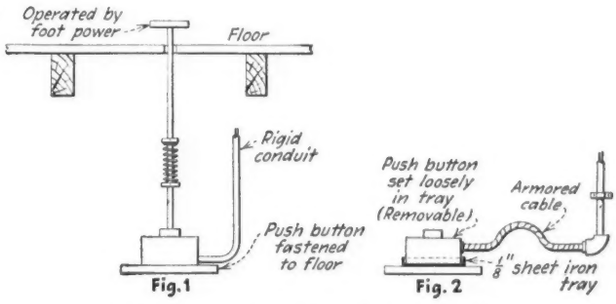
Repair was made by fitting a $\frac{3}{4}$-in. plate over the fracture and securing it by four $\frac{3}{4}$-in. bolts on either side. A steel plate of the required size was marked off and drilled, no clearance being allowed for the studs.

The plate was then made red hot and the pitch of the holes in the plate measured to determine the amount of expansion. A template was made of the plate, the pitch of the holes corresponding with the pitch of the holes in the hot plate. This template was used to mark off the stud positions on the valve chest. After the studs had been fitted the crack was filled with iron cement, the plate was made red hot again and put in place on the studs. As the plate cooled down it tended to draw the cover together, the nuts being tightened as it cooled. When the cover was replaced it was found to be tight, largely due to the efficiency of the shrinkage fit obtained.

Garden City, Herts, England. W. E. WARNER.

How Inspections and Repairs on Push-Button Stations Were Facilitated

IN SOME industries, where practically all the machines are motor driven, it is usual to find push buttons operated by foot power instead of manually. Often the stations are installed in rather inaccessible locations,



Original and improved method of installing push buttons

thereby causing serious delays when making repairs. To overcome this difficulty, in one plant the push buttons were placed in metal trays the sides of which fitted closely around the stations. Then the electrical connections were made with steel-armored cable, with a reasonable amount of slack in the cable.

Seattle, Wash. RALPH E. MACKAY.

From Among Readers' Problems

Conducted by
L. H. MORRISON

EFFECT OF POWER FACTOR ON ENGINE STEAM RATE—*What effect has low power factor on the water rate per kilowatt-hour of a steam engine operating on saturated steam at 140 lb. gage pressure and 5 lb. back pressure? The 240-volt, 60-cycle, 3-phase, 200-kva. generator is rated at 80 per cent power factor.*

The engine is supposed to have a steam rate of about 36 lb. per kilowatt-hour. As near as I can estimate, the steam rate is 50 lb. per kilowatt hour. P.E.

Unless the power factor is very low, say, 40 per cent, the generator efficiency should not be materially below the efficiency at 80 per cent power factor.

The increase in water rate is so marked that one is led to the conclusion that the engine's steam valves are leaking. The wattless current is not a load on the engine save that it increases the $I^2 R$ losses in the generator.

DEFLECTION OF OIL ENGINE SHAFT—*Various authorities have advised that the bearing wear and shaft deflection may be found by placing a dial indicator between the crank throws. The difference in the readings when the crank is at the top and bottom dead centers shows the deflection. But what is a dangerous value?* P.R.

The crank throw may be regarded as a beam fixed at the crankpin and loaded at the journal end. The reading of the dial indicator is then the deflection of the loaded beam. Calling the deflection a, the crank radius L in feet, and the throw thickness t in inches, then the stress f is $\frac{43{,}500\ a\ t}{L^2}$

When f is over 20,000 there is danger of shaft fracture at the junction of the crankpin and throw.

ZINC DUST FOR ICE TANK PROTECTION—*Will zinc dust added to the brine in an ice tank protect the cans from corrosion?* I.F.S.

Zinc dust has been tried in both sodium and calcium brines. In a new closed ice-making system using calcium brine 40 lb. of standard zinc dust was added per 1,000 cu.ft. This treatment gave an 80 per cent protection to iron and steel in the tank at first, but the corrosion rate gradually increased until at the end of five months the treatment showed only a 55 per cent protection in this tank. In another tank, however, acid had been added at the start of the treatment in order to bring the pH to 9. In this tank a 55 per cent protection was obtained for iron and steel, with a gradual decrease until the protection was only 27 per cent. No protection to galvanized metal was obtained in either tank by the zinc dust treatment.

CAST-IRON HEATING BOILER LOSES WATER—*Our low-pressure heating system seems to leak, since we are forced daily to add water. I have gone over the piping without discovering a fault, but I notice that the insulation on the cast-iron sectional boiler appears damp. Could the boiler leak?* J.M.

It is possible that the sections were not drawn up properly when the boiler was assembled, which might permit water to leak at the connecting nipples. The insulation should be removed and the boiler given a cold water test of, say, 25 lb. pressure per square inch.

NUMBER OF PISTON RINGS PER GROOVE—*Do you recommend the placing of two piston rings in a single groove? The grooves of the 22-in. pistons of our oil engine have become rough and it will be necessary to return the faces. We are thinking of using two narrow rings.* B.B.

There is no advantage in employing two narrow rings in a groove; in fact, the wear on the ring sides may be greater than before. This refers to plain rings. On the other hand, a two-piece ring designed to seal against gas blow-by is considered to be superior to a single ring. Before re-turning the grooves you should ascertain from a ring manufacturer the width of his standard dimensioned rings. With this information you are in a position to turn the grooves to the proper width.

BOILER HYDROSTATIC PRESSURE—*What hydrostatic pressure should be given a boiler?* C.G.S.

It is usual to make the hydrostatic pressure 50 per cent greater than the working pressure, that is, a 300-lb. test for a 200-lb. working pressure.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

ONE of the fundamental principles is that two gases in a container will separately fill the entire vessel, independent of the other's pressure, and the pressure exerted is the sum of the two gas pressures. This also applies to a vapor and a gas. If so why do not steam and air mix in a radiator? C.C.

THE HYPOTHESIS that all gases are completely miscible under all conditions and in any proportions is universally true. The process of mixing, however, is by no means instantaneous. The time interval between admission of the gases into the container and completion of solubility depends, among other things, on density, temperature, pressure, shape of container, and mechanical means available to hasten the mixing process.

In the case of a radiator, consisting as it does of several successive chambers interconnected only by a nipple at top and bottom, or bottom alone, we have a container ideally adapted to promote a condition of extremely slow diffusion. Steam usually enters at the top of one end of the radiator, leaving as condensation at the bottom of the opposite end. Air being slightly heavier than steam at pressures ordinarily used for heating, tends to fall to the bottom of the radiator and become stagnant. This is especially true of that end at which steam enters the radiator, because the inlet velocity tends to carry the steam directly over the air, allowing little opportunity for diffusion. The bottom of the outlet end of the radiator seldom becomes air-bound. The top may, since the velocity of wet steam traveling toward the outlet may be sufficient to offset the small differential in steam-air density when the steam has been cooled and the air warmed, and thus hold air in suspension.

Buffalo, N. Y. E. C. KEEFE.

AIR in a vessel containing water vapor, or steam, soon becomes saturated with water vapor, and a state of equilibrium is set up in which the amount of vapor in the air remains constant, providing the temperature remains constant. If the temperature is raised, the quantity of water vapor in the air increases. For ordinary temperatures and pressures, such as encountered in steam-heating systems, the pressure of saturated vapor varies from 0.88 lb. per square inch at 32 deg. F. to 100 lb. at 328 deg. F.

This discussion leads to the conclusions that steam and air do mix in a radiator and that the total pressure exerted on the radiator wall is equal to the sum of the steam and the air pressures. At 212 deg. F. the vapor pressure equals 14.7 lb. abs., which is the pressure of the air outside the radiator and is practically negligible. As an equal mixture of steam and air is only one-fourth as efficient for heating as is steam alone, the desirability of excluding air from the steam (or rejecting it if the system is not provided with check-type air vents) is obvious. HERBERT KOGEE.

Bozeman, Mont.

THAT a radiator in which a partial vacuum exists (ordinarily spoken of as a "vacuum") readily heats when steam is admitted to it is proof that steam and air actually mix in a radiator. A partial vacuum does not mean that the radiator is empty of air, but that the air in it is at a pressure less than that of the atmosphere. The ready heating of a radiator under such a condition, upon the admission of steam, shows that the rate of diffusion of steam through the air varies with the pressure.

Radiators in which a partial vacuum does not exist at the time steam is admitted do not heat so readily as do those in which a vacuum exists. This is because the steam does not mix with the air as readily under higher pressures as under lower pressures. This is one of the reasons that radiators in a one-pipe heating system do not heat as readily or as completely as in a vacuum system. Because a radiator from which the air has not been released before steam is admitted does not come up to steam temperature throughout its entire surface is not evidence that there is no mixing of air and steam. It is merely evidence that there is not complete mixing, or rapid mixing, under the conditions existing.

Neither do these observations prove that the accepted principle that a gas and a vapor in a container separately fill the entire vessel independently of the other's pressure and exert a pressure which is the sum of the pressures of each is incorrect. They are proof, however, that under the conditions existing the mixing does not proceed as rapidly or to the completeness it would under ideal conditions.

In all heat processes the time element is a factor. In some cases the rate is so rapid that the time interval is very small, while in others the rate is so slow that the time required is very long. For example, the rate of mixing of air and steam varies with the pressure, being slower for higher pressures and more rapid for lower pressures. The initial condition of the air and of the steam, as well as whether the steam is admitted so as to agitate the air, also have a bearing.

It can be shown that there is actually some mixing in a radiator from which the air is not released (the pressure being above atmosphere and substantially equal to boiler pressure). However, since the mixing occurs under relatively high pressures, and due to what may be termed "concentration differences," the rate of mixing is so slow as to make it correct, from a practical standpoint, to say that the air and steam do not mix. However, I do not believe this shows the above physical principle relative to gas and vapor mixtures to be incorrect under suitable conditions.

The foregoing could give rise to a deal of discussion, such as "Why does a vapor heating system secure relatively rapid filling of its radiators with steam?" Each is more or less of a special case, which can be readily explained in keeping with the accepted laws of gas vapor mixtures.

D. N. CROSTHWAIT, JR.

Marshalltown, Iowa.

AS STATED the principle is correct. The earth's atmosphere is a good example of a uniform mixture of gases. But in the case given the element involved is a liquid at room temperature and atmospheric pressure. If the air were at the same temperature as the steam, then the law would hold and the steam would occupy a volume proportional to its partial pressure.

When steam is turned into an air-filled radiator it first saturates the space, the per cent water vapor depending on the air temperature, and additional steam will condense before it can permeate the air. This will raise the air temperature in this condensing zone, which will, in turn, raise the saturation point. The air temperature will rise slowly and equilibrium will be reached when the rate of the condensation on the inner surface of the radiator equals the rate of steam diffusion through the air. As the rate at which condensation can take place on a surface from non-flowing saturated air is low, it is apparent that the air must be removed from the radiator before a good heat transfer can be obtained. C. S. COLLIER.

Wilmington, Del.

ACCORDING to the kinetic theory of gases, steam and air do mix in a radiator. Observation bears out the fact that, although rapid admission of steam to a cold radiator shows a stratifying action, resulting in only a portion of the radiator heating up at first, after sufficient time has elapsed to allow thorough diffusion of the gases (water vapor and air), the radiator temperature becomes uniform and the air discharged from the vent valve is saturated with water vapor at that temperature.

This temperature will not be the same as the temperature of the steam supplied to the radiator, because, according to the law of partial pressures, the steam will condense at a lower pressure in the presence of the other gases (air) in the radiator as long as they are present in appreciable volume.

To illustrate, assume that a radiator filled with air at a room temperature of 70 deg. F. when the steam was shut off, and that steam has been turned on so that the pressure in the radiator is one pound per square inch gage, which is 1 + 14.7, or 15.7 lb. per square inch absolute pressure. Assuming that the

A Question for Our Readers

WITH the increasing number of roller bearing installations in power stations and in the industrial field, an ever-increasing number of operating men are becoming interested in the maintenance of these bearings. I should like to invite the readers having such bearings under their care to express an opinion on the following questions:

What schedule of inspection and overhauling do you follow for these bearings?

Are the intervals between inspections longer or shorter than with babbitted bearings of comparable sizes? On what do you base this difference?

What external indications do your operators have of the condition of races and rollers upon which they base their judgment that these parts are in good working order or need inspection?

Suitable answers from readers will be paid for[1] and published in the April 28 number

[1] As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fitz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

steam is entering just fast enough to replace the volume lost by condensation, so that the volume relations may be considered constant for the moment, the partial pressure of the steam or water vapor when its volume is 3.2 per cent of the total volume is 3.2 per cent of the total absolute pressure, that is, $.032 \times 15.7 = 0.5$ lb. per square inch or 28.9 in vacuum. The properties of the steam will be the same as though it alone occupied the radiator volume. From the steam tables we find that the temperature of condensation at a pressure of 0.5 lb. per square inch is 80 deg. F.

The partial pressure of the air is, similarly, 96.8 per cent of 15.7, or 15.2 pounds per square inch. This air will be at a temperature of 80 degrees, since the condensation of the steam will be taking place at this temperature throughout the air-steam mixture at any point where the steam can give up its latent heat, and the air will be saturated with water vapor at this temperature.

A few moments later, as the steam is admitted faster by the venting action of the air valves, the proportion of steam to air by volume will become 8.3 per cent. At this point the partial pressure of the steam will be $0.083 \times 15.7 = 1.3$ lb. per square inch absolute, or 27.3 in vacuum, corresponding to a condensing temperature of 110 deg. F.

The condensing temperature cannot reach the temperature of the inlet steam as long as any other gas is present in the radiator; but the radiator will feel "hot" as soon as the steam-air mixture contains fifty per cent or more steam by volume.

L. H. ROLLER.

New Brunswick, N. J.

[None of these answers completely covers the question, and an article on the subject will appear in a future number.—EDITOR.]

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X-Rays, Radium and Magnetic Inspection Discussed by Welders and Steel Treaters

A PACKED HOUSE, good speakers, ultra-modern subjects, and lively discussion featured the joint meeting of the New York sections of the American Welding Society and the American Society for Steel Treating on March 9. The papers dealt with the X-ray inspection of welds, with the magnetic inspection of steel products, and with inspection by gamma rays from radium. All of these methods have been discussed previously in *Power*, but the papers and discussions revealed certain new angles of interest.

Methods used in the X-ray inspection of welds, the apparatus and results, were discussed by Mr. Isenberger of the St. John X-Ray Corporation. He spoke of the X-ray, not so much as a tool for routine inspection as a method of improving processes and technique, and men. That is to say, much of the X-ray work properly comes before production. The normal method of inspection is by photo films. The fluorescent screen cannot at present be used for metal thicknesses greater than ½ in. He showed a device whereby an operator could study steel by the fluorescent screen without danger from the rays. The average total cost of X-ray operation was given by Mr. Isenberger as $3 to $5 per hour.

The program of the meeting announced a paper on "Magnetic Inspection of Steel Products" by Dr. A. V. de Forest, magnetic physicist of the Welding Engineering & Research Corportion. On account of Mr. de Forest's illness, his paper was presented by A. B. Kinzell of the Union Carbide & Carbon Laboratories.

The de Forest method uses iron particles coated with a white non-magnetic substance. Heavy flux is passed through the piece to be tested, and the powder sprinkled on. Microscopic air gaps affect flux leakage, and lead to the accumulation of particles along these defects.

Direct current may be used, but Mr. Kinzell said that alternating current vibrates the particles and gives a more definite pattern. The method, he said, is extremely simple and sure. The equipment is not unduly expensive; an electroplating generator, or transformer, or storage battery set is sufficient. Flux densities ranging from 8,000 to 18,000 units are used. In closing, Mr. Kinzell referred to the growing use of the stethoscope test.

In his paper on gamma-ray inspection, Dr. R. F. Mehl presented material along the lines of his paper in *Power* (Feb. 24, 1931). In the discussion the speakers admitted that both X-rays and gamma rays have their dangers, but they pointed out that, with proper precautions, there is nothing to worry about. He gave the present price of radium as $70,000 a gram. The Navy has purchased a gram for radiographic work. He said that there is plenty of radium ore in the world.

Announcement was made at the meeting of 1931 nominees by the New York Section of the American Welding Society. These follow: chairman, H. M. Priest; first vice-chairman, J. B. Tinnon; second vice-chairman, H. H. Moss; secretary-treasurer, A. F. Keogh; member executive committee (term three years) Chas. Kandel, J. W. Owens, G. N. Bull, F. E. Rogers; member of executive committee (term two years) T. C. Fetherston; representative on national board of directors, P. W. Swain. Elections will be held in May.

Germany Rebuilds Iron and Steel Industry in 5 Years

RECONSTRUCTION of the German iron and steel industry in the comparatively brief period of five years has been accomplished by the adoption of the cartel system, it is stated in a comprehensive report just published by the National Industrial Conference Board, under the title "Rationalization of German Industry."

Under this system the iron and steel industry has shown an increase in the size of establishments, a decline in the total number of establishments and workers, and a marked increase in the output per worker. It is pointed out in the report that six large combines have emerged from the post-war chaos, each a well integrated unit equipped with the most up-to-date machinery for large-scale production. In spite of conflicting interests, these six combines have shown a remarkable willingness of co-operate and have renewed all cartel agreements for a period of ten years beginning Feb. 1. For all practical purposes, therefore, the industry is now being operated like a monopoly.

"The costly process of reconstruction is now completed," says the Conference Board "The iron and steel industry of Germany, as a whole, is better equipped for efficient production than that of any other European country and is not much behind that of the United States."

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U. of Illinois Announces Research Assistantships

APPLICATIONS for appointments to the fourteen research graduate assistantships maintained by the Engineering Experiment Station of the University of Illinois at Urbana are due on April 1, according to a recent announcement of the director of the station. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of research graduate assistant is made and must be accepted for two consecutive collegiate years of ten months each, at the expiration of which period, if all requirements have been met, the degree of master of science will be conferred. Half of the time of a research graduate assistant (approximately 900 clock-hours for each ten-month period) is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study. Research work and graduate study may be undertaken in all important branches of engineering and science.

Helical Groove Improves Operation Of Commutator and Slip Rings*

By G. M. LITTLE
Research Engineer
Westinghouse Elec. & Mfg. Co.

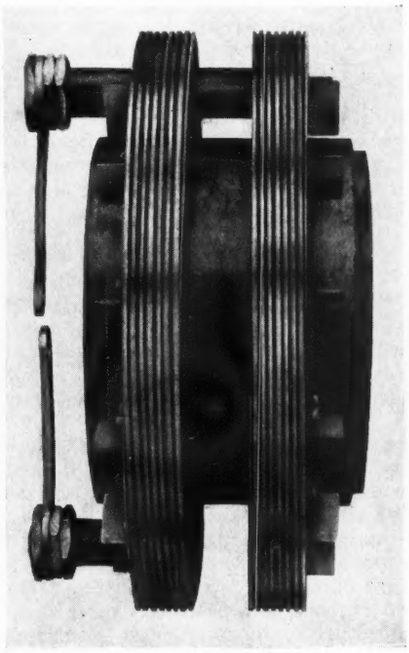
PERFORMANCE of brushes on slip rings and commutators is dependent on many more or less obscure conditions. This article is the result of an investigation of some of the causes of trouble that exists at the sliding contact between a brush and a rotating slip ring or commutator. It is a most plausible supposition that under normal running condition of a brush which is well fitted to a slip ring or commutator that the current flows across the sliding contact at all times through a multitude of tiny contacts distributed over the entire polished face of the brush. There is good evidence that this is only partly true.

It was shown that with a well-fitting brush riding on a smooth slip ring there is only a comparatively small number of minute contact points or groups of points concerned in carrying the current at any given instant. Under light pressure there may be from 3 to 6 active current-carrying spots, while under increased pressure 50 to 100 spots may be active.

The demonstration consisted in discharging a large condenser across the contact between the brush and the slip ring. This discharge, estimated to be at least 3,000 amp., lasting for only a few millionths of a second, was so rapid that although the slip ring was revolving at 1,500 r.p.m. the pattern burned on its face and on the brush consisted of a group of well-defined minute spots. The distribution of the spots over the brush face was found never to be the same in successive experiments. These spots constituted less than 3 per cent of the total area of the polished brush face.

It was observed that if the current density was very high, a brush was likely to glow and throw off white hot streamers. A study of this glowing confirmed, in the writer's mind, the correctness of the usual explanation of the cause, which is based on the negative temperature coefficient of carbon. If a brush is overloaded and one part of its face should by chance be a little warmer than another part, the current will tend to crowd into this warmer area, raising its temperature more and more until a low-resistance hot spot is developed, which then carries substantially all of the current.

It was observed that a hot spot of this kind will remain in one location on the brush face for many hundred revolutions of a commutator or slip ring, during which time all sparking of the brush will be stopped. This tendency of a spot to take all the current and to hold to one position on the brush face is further promoted by the local expansion of the hot carbon. This expansion causes the hot spot to become slightly raised above the polished surface, and the brush rides on this "hill" until it is worn down. During this time most of the spring pressure is concentrated on the minute raised area. The local temperature rise due to friction is thus probably a large contributor to the stationary hot-spot condition.



Spirally grooved rings for a 15,000-kva. synchronous condenser

A very convincing observation of this action was made on a badly overloaded glowing brush riding on a slip ring. The expansion at the hot spot was so great that it raised the brush off of the slip ring noticeably, and it was possible to see through the gaps on either side of the hill. With these observations in mind, it was assumed that if the current passing through the hot spot could be stopped and some other portion of the brush face, or a parallel-connected brush, could be forced to take the load for a portion of each revolution of the commutator, operation would be improved. During this period the hot spot would have an appreciable time to cool, and a more uniform distribution of current under the brush face and between parallel-connected brushes would result, together with an absence of local spot-heating and glowing.

Two expedients were evolved, (1) a row of side-by-side, straight-around, offset grooves, and (2) the helical groove. Both schemes were tried and gave similar results, but the helical groove was easier and cheaper to make and could, if necessary, be cleaned more readily. In both schemes a given spot on the face of the brush can carry current and be subjected to fritcional heating for only a portion of each revolution of the slip ring or commutator, during which time some other spot or group of spots is forced to carry the load. Any air trapped under the brush face, which is a contributing factor in uneven current distribution, is permitted to escape, as are any loose abrasive, solid particles of brush or ring material.

Tests showed that the helical groove improved the performance of brushes on a slip ring very much. It is not unusual on a commercial slip ring to find that practically all of the current is being carried by only one or two brushes out of a set of five or more connected in parallel. These two brushes will carry this overload for hours, then become idle, and one or two of the others will take on the load for a time. This treatment works a serious injury to the flexible copper connections, oxidizing them and raising the resistance of the joint between the shunt and the brush. The overloaded brushes waste away much faster than those carrying their correct rated load.

Tests were made to determine what effect grooving a slip ring had on the contact resistance. Use was made of two copper slip rings, one plain and one grooved, mounted on the same shaft. Each was equipped with one positive and one negative brush, and the rings were so arranged that they could be operated either in series or in parallel.

At the start, with clean sandpapered rings and brushes, the contact resistance on both rings was extremely low, but the grooved ring brush contact was almost always much lower than that of the plain ring. The resistance of both rings then slowly increased until the resistance of the grooved ring and brushes became about 20 per cent higher than that of the plain ring and its brushes, which sometimes took 20 or 30 hours.

At the beginning of this test, it would

*Abstract of a paper, "The Application of the Helical Groove to Slip Rings and Commutators," presented at the winter convention of the American Institute of Electrical Engineers, in New York City, Jan. 26 to 30, 1931.

appear that no film or polish having a high resistance was present, and the bare surface of the grooved ring had the lower contact resistance, even though the available contact area was much smaller. This was because the spring exerted a greater pressure per square inch on the smaller area of the grooved ring. In this instance this pressure was about three times that on the plain ring. Apparently, as the test proceeded, there was a high-resistance film or polish slowly formed on the sliding surfaces. This film on the grooved ring and its brushes finally became higher in resistance than that which formed on the plain ring and its brushes.

With certain brushes that were running on a plain and a grooved ring connected in parallel and supplied with a constant current, it was usual to find after the day's run that the warm grooved ring had the higher resistance and was taking 5 amp., while the warm plain ring was taking 10 amp. After shutting down for the night and starting in the morning both rings were found to have acquired a high resistance, and usually the grooved ring was initially the lower of the two. This grooved ring would start off with 10 amp., while the plain one took 5, a condition that often lasted for hours, though finally a return to the former state always occurred as the rings became warm.

Laboratory investigation of the application of a helical groove to a commutator disclosed some interesting information. One of the first trials was made on a defective direct-current 2,000-amp., 500-volt generator. This machine would carry one-half to three-fourths load satisfactorily, but on full load trouble would develop in a few hours time, and on 150 per cent rated load glowing, sparking, and streamers would develop within ten minutes

Grooved Commutator Runs Cooler

After the commutator was grooved $\frac{3}{8}$ in. pitch, $\frac{1}{8}$ in. groove, the machine carried full load over a week with no glowing, and stood the 50 per cent overload for 3 hr. It was also noted that the grooved commutator ran 10 deg. cooler than the plain commutator. Later this same grooved-commutator machine was operated at full load, and 8 out of the 44 brushes were removed and no distress was observed. This suggested the possibility of building shorter and less expensive commutators.

It appeared from the tests that grooving a commutator probably does much more than prevent the formation of hot spots. The cooler operation suggested that the wasteful circulating current which occurs under a brush face during ordinary commutation had probably been reduced, and this could only be explained by supposing that in some way the contact resistance had been raised.

The observed reduction in the sparking at the trailing edge of brushes on a grooved commutator may be explained by the increased contact resistance. This resistance serves to cut down the volume of circulating current which the spark has to handle, but there is another explanation that may be even more plausible.

It is common belief that an arc (a spark) can be formed in air only if the temperature of the separating contacts is high enough to ionize the air and make it a conductor. As the helical groove on a commutator prevents any large rise in temperature of contact spots under the brush face, it is probable that the small arc-starting spots at the trailing edge of a brush and under the brush face are to some extent prevented from reaching the temperature necessary to ionize the air and start the spark.

The depth of the groove has little or no effect on the performance, though it is reasonable to expect that a deep groove might promote cooler operating due to the increased radiating surface and the larger amount of cooling air that is dragged across the brush face.

Dimensions Dictated by Service Requirements

The width of the groove and the pitch of the thread are being studied, and it would appear that to secure the best results in different kinds of service these dimensions will be varied considerably.

When a helical groove is cut in a commutator or slip ring the available sliding contact area is reduced, and, with no change in the spring pressure, the pressure per unit area is raised.

If increase in the unit area pressure is prevented by lowering the spring pressure on the grooved ring brush, a rise in the contact resistance is more easily and surely shown. It is possible to lower the spring pressure on a grooved ring to a greater extent than can be done on a plain ring without causing sparking, but this must not be done if there is any vibration.

The appearance of a grooved commutator while it is rotating conveys an impression that there must be a powerful action tending to drag the brushes toward one end of the shaft. But no such tendency exists, as the brushes slide on the tops of the ridges.

After grooving a commutator it is desirable to stone the surface and to round the edges of the spiral slightly, as any burr left is disastrous to brush life, and sandpapering alone is not effective. For subsequent polishing a very fine sandpaper backed by a wooden block is best.

The slip ring tests were so convincing that when the information was given to a public service company it decided to co-operate in an experiment on the rings of one of its 13,000-amp. rotary converters. The operation was so satisfactory that the company is now having another machine grooved and put into service. Another utility is putting in operation a large synchronous condenser equipped with hydrogen inclosed steel slip rings with helically grooved surfaces. The figure shows the rings for a 15,000-kva. synchronous condenser. These rings have a $\frac{1}{8}$-in., $\frac{1}{2}$-in. pitch helix, with a $\frac{1}{8}$-in. groove between its turns.

Canada Has 617 Hp. Per 1,000 Population

According to a report just issued by the Dominion Water Power Bureau, the total hydraulic installation of Canada now averages 617 hp. per 1,000 of population, a figure which places the Dominion in an outstanding position among the water-power-using countries of the world.

The steadily increasing proportion of new hydraulic installation developed by central electric station organizations has resulted in that industry's operating 5,214,336 hp., or over 85.1 per cent., of Canada's total hydraulic development. The central station industry now includes 321 hydraulic stations with 843 hydraulic turbines. Of these, 222 stations, with a combined installation of 3,803,288 hp., are owned by commercial organizations (joint stock companies or private individuals) and 99 stations, with a combined installation of 1,411,048 hp., by municipalities.

The pulp and paper industry now maintains a hydraulic installation totalling 579,826 hp., and it is interesting to note that over one-half, 296,843 hp., is connected to electric generators. In addition, power to operate motors of a combined rating of 944,272 hp. is purchased from central stations, giving a total electrical utilization by the industry of 1,241,115 hp. out of the total hydraulic utilization of 1,1524,098 horsepower.

▼

New Zealand to Try Out Steam-Driven Buses

Steam-propelled buses, believed by their New Zealand promoters to offer a possible substitute for the gasoline-driven type now in use in Auckland, will shortly be given trials under passenger service conditions in that city, states an article in the New Zealand *Herald*, according to Counsul Walter F. Boyle, of the United States Department of Commerce.

Outwardly the bus will differ very little from those now in use but it is claimed that the quiet running and smooth, silent acceleration will distinguish it from other vehicles.

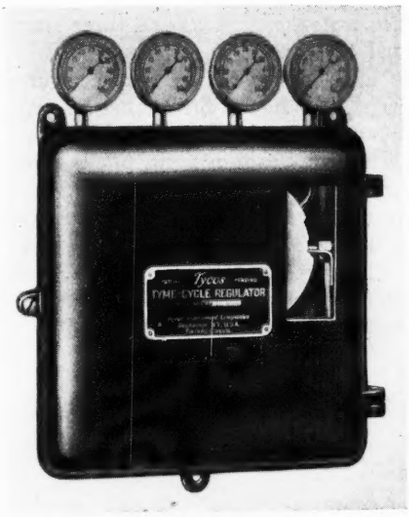
The boiler, consisting of a series of coiled tubes, has been placed in the space previously occupied by the gasoline motor, and a condenser to return the exhaust steam to water for renewing the boiler supply has been placed in the position of the radiator, giving the same appearance as formerly. The engine is under the floor of the bus just in front of the rear axle, thus doing away with the loft drive shaft, and the cylinders are packed and encased to prevent the escape of heat. Speed is governed by a throttle wheel within the steering wheel which can be operated by the thumb, it is said. Reversing is done by means of a foot pedal, there being no gear-shift lever.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Time-Cycle Regulator

WHERE various mechanical functions are actuated by pneumatically or hydraulically operated pistons, diaphragm valves or electro-



Time-cycle regulator to operate four valves

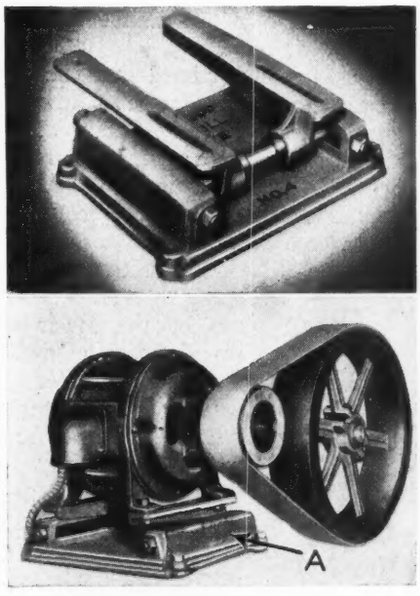
pneumatic switches, the Tycos "Tyme-Cycle" regulator illustrated will automatically control such operations according to a predetermined time schedule. The motive power for the instrument is 25-lb. pressure compressed air. This can, however, be varied to suit requirements of the individual application.

This type of instrument consists of an electrically driven cam which, as it revolves, progressively opens or closes small pilot valves. The latter, in turn, regulate the supply of compressed air to diaphragm valves, electro-pneumatic switches, or other pneumatically operated devices. The cam is mounted on a shaft which rotates in ball bearings. Steps are cut on the cam corresponding to the number of pilot air valves to be operated. Cam speed can be increased or decreased to meet new requirements of the process by substituting new cams and gears. This changeover is readily accomplished by the user.

The regulator is put out by the Taylor Instrument Companies, Rochester, N. Y.

Improved Short-Center Flat-Belt Drive

IN THE June 18, 1929, number of *Power,* one form of short-center flat belt drive put out by the Rockwood Manufacturing Company, Indianapolis, Ind., was illustrated and described. Since that description appeared certain improvements have been made in the drive. A standard unit in six sizes is now available to cover all requirements for motors from 1 to 50 hp. at 1,800 revolutions per minute.



Standard motor base and complete drive

Referring to the illustration, the standard bases provide simple adjustments for motor size, pulley alignment and belt length, and the design eliminates the need for the usual motor rails. Also, the same base is suitable for use on floor, wall or ceiling.

Uniform belt tension, which is a feature of this drive, is obtained by mounting the motor on a pivot as indicated at *A* in the lower view, the overhang of the motor giving sufficient weight to maintain proper belt tension.

Instrument for Colorimetric pH Control

THE ILLUSTRATION shows a new set for pH control work, known as the "slide comparator," recently introduced by W. A. Taylor & Company, Inc., 872 Linden Ave., Baltimore, Md.

The device consists of two principal parts, the slide and the base. The slide is a bakelite case 10 in. long, $2\frac{3}{4}$ in. high and $\frac{5}{8}$ in. thick. It contains 17 vertical holes and 17 horizontal slots, which pass through the exact centers of the holes. In these holes are placed the nine color standards for any given indicator and eight ampoules of distilled water. The ampoules are held in place by a lid which is screwed on the top of the slide.

The base consists of two parts. The lower part contains a slot in which the slide may be moved back and forth, two holes containing vials of indicator solution, five holes containing test tubes, and a closed compartment for a ground-glass plate. Vertical slots run through the three central holes in the base holding the test tubes, these slots corresponding exactly with any three of the slots in the slide.

In making determinations the top is removed from the base, three of the test tubes are filled to the mark (5 c.c.) with the sample to be tested and placed in the three holes back of the slots in the base. To the central tube 0.5 cc. of the indicator solution is added by means of the pipette and nipple, and the contents are thoroughly mixed. The slide containing the color standards is now placed in position on the base and, holding the instrument toward a window or other

Slide comparator for pH control

source or daylight, the slide is moved back and forth in front of the test samples until a color match is obtained. The pH is then read off directly from the values on the front of the slide.

It is pointed out by the manufacturer that with the color standards inclosed in a bakelite case there are no loose standards to be inserted and removed in making pH determinations. Thus all chance of loss or breakage from handling individual standards is eliminated.

Slide comparators are supplied to cover the pH range 0.2 to 13.6. Each comparator covers a range of 1.6 pH units, the standards being in intervals of 0.2 pH.

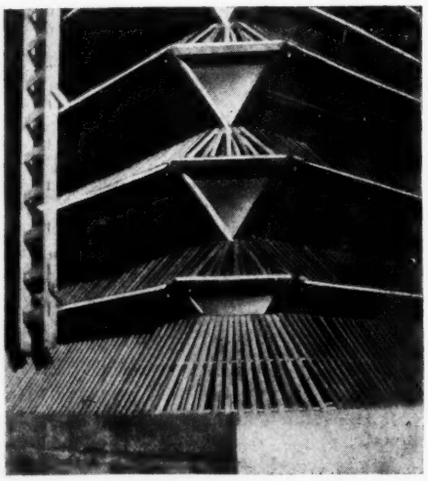
To meet the need of those who require a portable set covering a wide pH range, a long-range instrument has been made available. This set is made in five models, to cover the range of any 3 to 7 indicators, respectively, between the limits of 0.2 and 13.6 pH. Each long-range instrument contains one complete slide comparator; 2 to 6 extra color standard slides; vials of the corresponding indicator solutions, with pipettes and nipples; and a supply of 5 cc. test tubes. This equipment is contained in a portable case 11 in. long, 9½ in. wide and 4½ in. high.

Spray-Deck Cooling Tower With Primary and Secondary Louvers

AMONG the claims made for the improved design of spray-deck cooling tower equipped with primary and secondary louvers recently developed by the Marley Company, Kansas City, Mo., are provision for more air at uniform velocity, elimination of excessive moisture entrainment and reduction of drift losses to a minimum.

This new louver system involves the use of two separate sets of louvers. The first, or primary louvers are solid, being inclined outward and upward away from the tower. The secondary louvers are placed at right angles to the primary louvers and extend across the entire space between them.

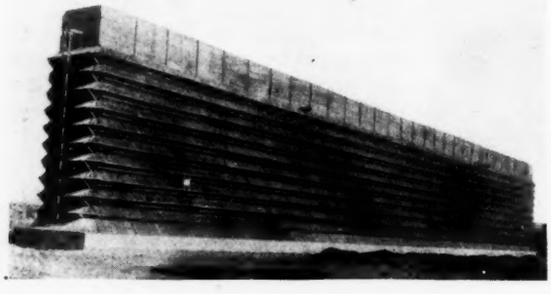
The width of the openings between the primary louvers, which are placed adjacent to each deck to effectively



Enlarged view of secondary louvers

care for the splash or rebound created by the water's impact against the decks, is nearly doubled. The secondary louvers are spaced as shown in the illustration, to give the added draft resistance to compensate for opening up the primary louvers and at the same time effectively force air equally to all parts of the tower. It is claimed that air cannot lane or stratify at any point.

It is further claimed that the air leaves the deck area, passing outward with uniform velocity, thus eliminating excessive moisture entrainment. Where moisture is entrained it is deposited on the exit secondary louvers, which also serve as effective drift eliminators. The spray system in the top of the tower is supplied by a main distributing header to which all nozzles are attached. Decks are of rough-surfaced redwood and are arranged and spaced so that all falling water is arrested and splashed at each deck.



General view of a complete tower

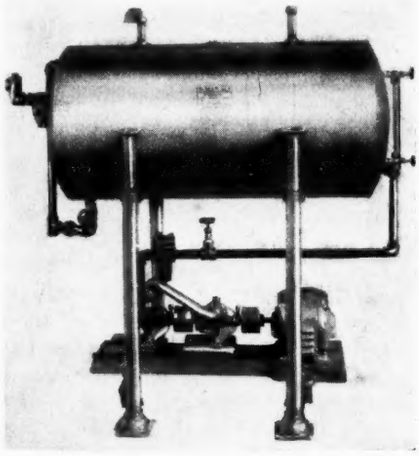
Automatic Feed-Water Unit

CONSISTING of a receiving tank, pump and motor assembly and automatic control, the feed-water units put out by Steam & Combustion Company, 205 West Wacker Drive, Chicago, Ill., are suitable for boiler capacities from 50 to 2,150 sq.ft. and for working pressures up to 125 pounds.

The tank, which is vented to the atmosphere, receives condensate from return lines as well as the necessary make-up water from the city mains or other source of supply. From the tank the water is fed to the boiler by a motor-driven pumping unit consisting of a Westco pump in single or dual stages directly connected to an inclosed type motor. Automatic operation of the pumping unit is controlled by a water-level control mounted on the boiler. This control, in addition to being equipped with a float-actuated mercury switch for normal operation and a safety control water cut-out switch, carries a standard water-gage glass and three standard try-cocks.

Make-up water to the receiver is regulated by a float-actuated valve mounted on the end of the tank. A sediment strainer is an integral part of the control. An automatic compound feeder for use with the system can also be supplied.

The receiver is equipped with telescoping legs by means of which the height of the receiver may be changed



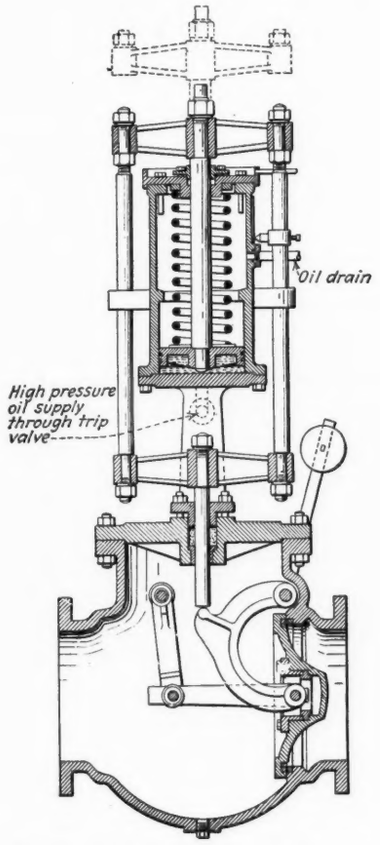
Boiler-feeding unit with two pumps connected in series

to meet different headroom or space requirements.

Sizes available for boiler pressures up to 60 lb. range in capacities from 120 to 1,320 gal. an hour; for pressures up to 100 lb., from 144 to 1,488 gal. an hour; and for pressures up to 125 lb., 120 to 1,296 gal. an hour.

Oil-Operated Bleeder-Line Check Valves

FOR USE in turbine bleeder lines and similar services where an automatic or positive stop of reverse flow is required a swing check valve



Swing check valve with oil-operating cylinder

with oil-operating cylinder has been introduced by Schutte & Koerting Company, Philadelphia, Pa.

In a typical installation this valve is put in the bleeder line at a convenient point adjacent to the turbine. High-pressure oil for operating the closing piston is supplied from the main lubricating system of the turbine or from an independent source. In either case the oil is passed through a three-way valve connected to the emergency overspeed governor of the turbine. When this governor operates, the turbine throttle valve and the oil-trip valve are tripped shut. This relieves the oil pressure from below the piston, and the spring in the valve cylinder forces the piston and stem down, closing the bleeder valve tight and preventing back flow of low-pressure steam through the extraction line. The oil from the cylinder returns through the valve to the oil reservoir.

As will be seen from the illustration, there is no positive connection between the valve disk and the spindle attached to the piston. The valve is, therefore, under normal operating conditions, free to swing open and shut automatically with changes in flow through the line.

An important feature of the valve is the crossbar and side-rod method of connecting the piston to the valve spindle without the use of a stuffing box in the bottom of the cylinder. This design eliminates any tendency of the spindle to stick and prevents the oil from dripping on the hot valve cover. Drain connections are provided to carry off any oil that leaks past the piston or collects on the upper cylinder cover.

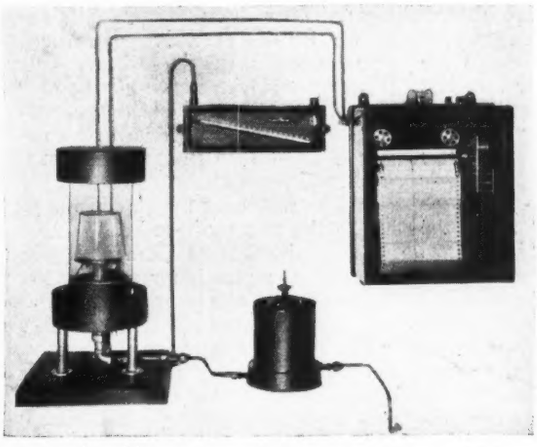
This valve is made in two styles; sizes up to 12 in. have the flapper disk with single link suspensions, while sizes above 12 in. have parallel motion disk with double-link suspension, as shown in the illustration.

Flame Analyzer Measures and Controls Heating Effect of Gases

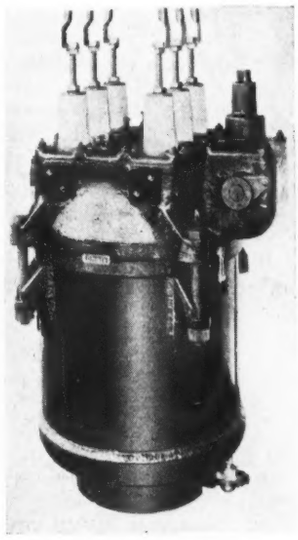
A RECENT ADDITION to the line of instruments put out by the Brown Instrument Company, Philadelphia, Pa., is the "Flame Analyzer," especially designed to check the heating effect of fuel gas. The instrument can be supplied to measure, record and automatically control the heating effect of any gas. With this instrument industrial plants using producer gas, and plants supplying butane gas, are enabled to check and regulate the quality of their gas output with special reference to heating effect. In cases where it is necessary to dilute a rich gas, or enrich a lean gas, the flame analyzer equipment makes it possible to observe and record the quality of the output and gives automatic control of the mixture, insuring a uniform product.

In certain industrial processes where uniform heating effectiveness of a gas fuel is vital, or where the rate of heat propagation must be maintained at a constant value, the automatic control type of flame analyzer will, it is claimed, maintain a uniform pilot flame in the analyzer, which, in turn, will result in unvarying flames throughout the plant.

The accompanying illustration shows the flame analyzer together with the recording instrument and a pressure governor and gage controlling the flow of gas through the analyzer.



Flame analyzer with recorder and pressure governor



Type DR60 indoor circuit breaker

Indoor Oil Circuit Breaker

A NEW indoor oil circuit breaker known as type DR60, offering such features as all poles in one tank, totally inclosed mechanism, gasketed joint between tank and frame, oil and gas separator and loop contacts, has been brought out by the Condit Electrical Manufacturing Corporation, Boston, Mass. Some of the advantages are smaller space requirements, quick clearing operation and freedom from oil throwing.

It is furnished three-pole, manually or electrically operated, for 600 and 1,200 amp., 15,000 volts, with an estimated interrupting capacity of 6,000 amperes.

NEWS of the FIELD

State Legislatures Consider Many Bills Affecting Utility Power Companies

New York, Pennsylvania, Oregon, Wisconsin, Kansas, Idaho, and Iowa propose more effective regulation

As A RESULT of increased public interest in power problems, state Legislatures all over the country are considering measures to make the regulation of public utilities more effective. Some of these bills have already been passed, while others are still in committee. The following is a résumé of the more important legislation.

In New York minority leaders of the Legislature have introduced a measure which proposes a new policy for rate making, based upon a legislative finding that the present method of regulating rates has completely broken down. The bill provides for a state-wide revaluation of all existing utility properties to establish an accurate rate base upon which a fair return can be fixed. After the rate base is established, all new properties are to be valued at actual cost. A definite prohibition is imposed upon companies against placing undue burdens on small consumers in fixing rate schedules and also against imposing various kinds of service charges. The Public Service Commission is to have supervision over all fees paid by a company to affiliated interests for engineering, financial, legal and accounting services.

The governor and Legislature of Oregon have approved three measures purported to carry out the wishes of the voters as expressed at the election last November. One provides for the creation of people's public utility districts to acquire or construct power plants and engage in the generation and distribution of electricity, all property of such districts to be assessed and taxed the same as privately owned utility property. The second bill, modeled after the Federal Water Power Act, prescribes a new water appropriation code for the state and creates a hydro-electric commission, consisting of the state engineer and two appointees of the Governor, to issue licenses for the utilization of the water. The third act abolishes the Public Service Commission and substitutes a single Public Utilities Commissioner.

In Wisconsin the State Senate has adopted a resolution calling for a referendum on the question of the state's going into the electric power business, as recommended by Governor La Follette. The proposed constitutional amendment would permit the state and its subdivisions to own and operate utility enterprises and acquire waterpower sites now under lease to private corporations until 1941.

Jurisdiction over utility holding companies is conferred upon the Public Service Commission in Kansas by a bill passed by the Legislature. Under the terms of this measure, no foreign holding company shall acquire control of a local utility without first agreeing to submit to the commission the matter of rates and other transactions affecting the operating company. Management, engineering and similar contracts are made subject to the approval of the commission.

RECOMMENDATIONS for the creation of people's counsel to represent the public before the Public Service Commission, with a provision for financing the public in their complaints, and for a law requiring commission approval of public utility securities were made by the Senate Investigating Committee in a preliminary report to the Pennsylvania Senate. Bills to carry out these recommendations have been introduced in addition to other proposed legislation to strengthen the public service law. A measure has been introduced in the House for the creation of a hydro-electric board in the Department of Property and Supplies to have charge of the management of electric generating plants and transmission lines to be owned and operated by the commonwealth. Power generated at such plants would be sold to municipalities, according to the terms of the bill.

A Public Service Commission with powers of regulation applying to all forms of utility enterprises is proposed by a bill introduced in the Iowa Legislature. This measure is said to embrace the ideas of utility regulation favored by Governor Turner, who called for a new regulatory body in his inaugural address. The new commission would include the present three members of the Board of Railroad Commissioners along with two other members to be appointed by the governor, and would be authorized to regulate all services, rates and charges of every form.

A bill providing for the levying of a tax of ½ mill per kilowatt-hour on all electric power generated in Idaho has been passed by the Legislature and signed by Governor Ross. This new law makes Idaho the only state in the Union to levy a direct tax on all power generated.

Hudson County Railroads Form Smoke Association

ONE of the most important accomplishments during the past month toward abolishment of the smoke nuisance in Hudson County, N. J., was the organization meeting of the Railroad Smoke Association, it is stated in the monthly progress report of the Department of Smoke Regulation for Hudson County, made public recently by William G. Christy, smoke abatement engineer. The meeting was held at Stevens Institute of Technology with some 50 representatives of the nine railroads operating in the county in attendance. A nominating committee was chosen to nominate officers and directors and select a name for the organization.

Mr. Christy reports that during the month several officials of corporations operating plants in the county voluntarily assured him of their co-operation in the campaign for smoke abatement and that owners of four plants, the stacks of which had been smoking, took immediate steps to stop the nuisance.

Seattle Council Supports Ross by Eight to One Vote

EXPRESSING ITS CONFIDENCE in J. D. Ross, former head of the municipal lighting department, and declaring charges brought against him by Mayor Edwards as reported last week to be groundless, the Seattle City Council on March 16, by a vote of eight to one, adopted a resolution requesting the Mayor to withdraw his nomination of Armand F. Marion as head of the department. The Council informed the Mayor that "under the existing circumstances" it will confirm no one but Ross.

In retaliation for the Mayor's action

in summarily dismissing Superintendent Ross, the Citizens' Municipal Protective League demanded the impeachment of Mr. Edwards by the Council, charging the Mayor on eleven counts with violation of his oath of office, and those charges were referred to a committee for formal consideration. They included alleged violation of oath of office in the appointment of City Engineer R. H. Thomsen, Superintendent of Public Utilities, George B. Avery, and Superintendent of Water William Severyns.

The Council's expression of confidence in Mr. Ross was voted after the Mayor's written charges had been read and Ross had replied both orally and in a long written statement. Unless the Mayor reinstates Mr. Ross or the Council rescinds its action, the lighting department for the next fifteen months will operate under the direction of Glen Smith, the assistant superintendent.

Commission Gets Records For Niagara Valuation

BREAKING A DEADLOCK of many years which has prevented the valuation of the Niagara Falls power plants, the Federal Power Commission gained access to the books of the Niagara Falls Power Company on March 17, as a result of an informal conference with Randall J. LeBoeuf, Jr., counsel, and Col. William Kelly, vice-president of the company.

The federal license for this project was issued in March, 1921, and under its terms a determination of fair value of the property by the commission is required, but for years the completion of this task has been prevented through the fact that access to the books of the antecedent companies was not granted. This obstacle is now removed, for Mr. LeBoeuf assured the commission that all records and books of both the licensee company and its predecessors would be opened for examination.

The attitude of the company "to make a full and complete presentation of all facts surrounding the power development and license at Niagara Falls" will facilitate the commission in carrying out its work in conformity with the spirit and purpose of the Federal Water Power Act. Work by the federal engineers and accountants under the plan of procedure agreed upon at the conference will begin early in April.

A.S.M.E. Metropolitan Student Branch Convention

THE SIXTEENTH ANNUAL Metropolitan Student Branch Convention of the American Society of Mechanical Engineers was held in New York City on March 11, with an all-day program featuring inspection trips, afternoon and evening technical sessions, and a dinner at the Fraternities Club.

In the morning various groups attending the convention visited the Ford plant at Edgewater, N. J., the steamship Pennsylvania, the Empire State and Daily News Buildings, and the Westinghouse Lighting Institute. Technical papers were presented in the afternoon on "Human Engineering," by Dr. Johnson O'Connor; "Modern Uses of the Gyroscope," by R. L. Witham; "Serpent Poisons," by Dr. Raymond L. Ditmars, and a film was shown depicting "The Story of a Mexican Oil Gusher." Ely C. Hutchinson greeted the students at dinner, at which a number of the older members of the society were present. In the evening J. A. Piacitelli read a paper on "Motion Study," and Professor Alexander Klemin talked on the development of aviation.

News of Canada

Dominion not ready to develop St. Lawrence—Quebec grants added flow to Beauharnois—New unit for Saskatoon steam plants

IN THE SPEECH from the throne delivered at the recent opening of the Canadian Parliament, there was absolutely no reference to the St. Lawrence waterway project. This confirms the general belief that the Dominion Government is not prepared to proceed in the immediate future with the improvement of navigation and the development of power on the St. Lawrence. It is observed that, while every other major question or problem at present facing Canada was dealt with, the speech made no mention whatever of the seaway scheme, and it is assumed that the government will not move in the matter until the position of the National Exchequer is considerably improved. Some of the cabinet ministers are strongly in favor of development of the seaway without further delay, but Premier Bennett is disposed to move with caution, though he is committed to the project by election pledges.

THE QUEBEC GOVERNMENT has finally passed the necessary order-in-council permitting the Beauharnois Power Corporation to divert an additional flow of water to enable the company to develop a greater output at the power plant now under construction at Beauharnois on the St. Lawrence River, above Montreal. The project was originally planned for an ultimate capacity of 500,000 hp. It was stated in the application that additional power would be needed to supply industries which

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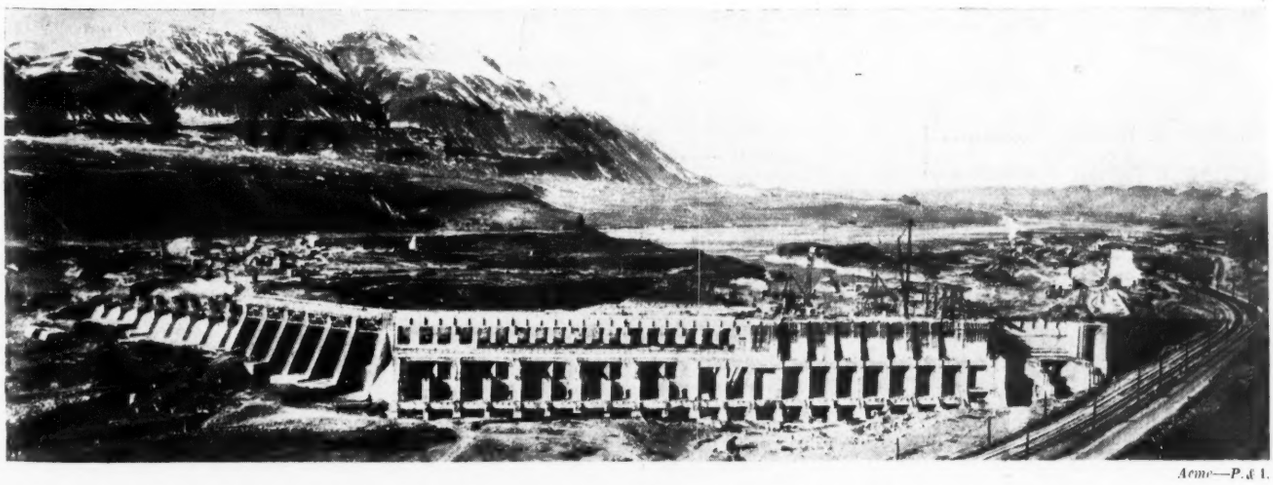

Acme—P. & I.

Dry weather has aided the progress of construction on the 252,000-hp. hydro-electric development at Rock Island on the Columbia River, Wash., which Stone & Webster Engineering Corporation is building for the Puget Sound Power & Light Company, at a total cost of $28,000,000. In the foreground is the power house; back of the spillway, left, will be a fishway so that the salmon can get up the river to spawn. The first four units, of 21,000 hp. each, will be in service by August, 1932

were expected to be established in the vicinity of the power development. The additional privilege has been granted on a lease which expires in the year 2003 and the additional rental will be $15,000 per year for the five-year construction period and thereafter $37,500. The additional right is subject to approval of the Dominion.

A SECOND ADDITION to the steam power station at Saskatoon is planned by the Government of Saskatchewan. This plant, which forms the nucleus of the northern distribution system, operated by the Saskatchewan Power Commission, was purchased from the City of Saskatoon late in 1928, and its capacity was then doubled by an addition of 10,000 kw. Contained in the capital estimates of public works, now before the provincial legislature, there is an item of $400,000 to provide for the addition of a 15,000-kw. unit to the Saskatoon plant, which will bring its total capacity to 35,000 kilowatts.

American Firms in Deal to Buy Berlin Power Plants

PRELIMINARY NEGOTIATIONS for the formation of a new corporation with a capital of $57,100,000 to take over the electric power system of Berlin, Germany, were concluded March 19 with the acceptance by that city of a $17,850,000 loan from an international banking group including four American firms. The American group is expected to acquire a third interest in the new corporation and to turn this over to the United Light & Power Company, which will thereby make its debut in the European utility field. The United company will not operate the property.

According to utility officials, the Berlin system is in need of additions and improvements, although two of its steam plants, the Klingenberg and West stations, are among the most efficient in Germany. Berlin will receive a portion of the income of the new undertaking and reserves the right to repurchase the system after 25 years.

Foster Wheeler Acquires Connelly Boiler Company

FOSTER WHEELER CORPORATION of New York announces that it has entered the field of boiler manufacture and is prepared to furnish all types in the entire range of sizes and pressures. Acquisition of the plant and business of the D. Connelly Boiler Company of Cleveland, Ohio, has placed the corporation in a position to cover the boiler field, and it can now undertake single contracts with undivided responsibility as to design, construction and operation for complete steam generators, including pulverized-fuel equipment, water-cooled furnaces, superheaters, economizers, air heaters.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-16. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Spring meeting at the Hotel President, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Heating and Piping Contractors. Annual convention in Louisville, Ky., May 6-9. Chairman of convention committee, M. J. Chagnard, 419 West Jefferson St., Louisville, Ky.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

FRANCIS HODGKINSON, consulting engineer of the Westinghouse Electric & Manufacturing Company and an authority on steam turbines, has been awarded the Williams gold medal by the British Institution of Mechanical Engineers for the best paper published in the *Proceedings* of the Institution from 1925 to 1930 inclusive, "dealing with such a general subject as the utilization or transformation of energy, treated especially from the point of view of efficiency or economy." Mr. Hodgkinson's paper was entitled "Journal Bearing Practices" and was published in 1929.

JOHN H. SMITH has been appointed chief engineer of the surface condensers department of Alco Products, Inc., a division of the American Locomotive Company. Mr. Smith brings to his new post more than sixteen years of wide experience in the engineering and sale of steam condensers.

C. M. THOMAS, attorney of Medford, Ore., and formerly circuit judge of the first judicial district of Oregon, has been appointed by the governor to the new post of Commissioner of Public Utilities of Oregon, in accordance with the law just passed by the state legislature and signed by the governor. The new law automatically abolished the former Public Service Commission consisting of three members.

GEORGE H. STOCKBRIDGE, transmission engineer of the Southern California Edison Company, has been awarded the John B. Miller distinguished service medal for outstanding accomplishments during his long career with the company. Mr. Miller is chairman of the Edison company and inaugurated the award in 1928 with its presentation for the first time to R. H. Ballard, president of the company. Mr. Stockbridge, who has to his credit many inventions for the improvement of electric transmission, retired from active service on Jan. 1, after 28 years with the company.

R. H. BENNETT, JR., for the past six years with the operating department of the Tennessee Electric Power Company, has been appointed superintendent of the production department in charge of operation and maintenance of all company hydro and steam generating developments to succeed H. H. BAILEY, who has assumed new duties as assistant manager of the Chattanooga district.

LESLIE R. HICKS, formerly electrical engineer of M. J. Daley & Company and at one time head of the electrical engineering department of Charles H. Tenney & Company, has joined the engineering staff of the Western Massachusetts Companies, with headquarters at Springfield. T. B. FLEMING, transformer specialist of the Westinghouse Electric & Manufacturing Company, has also joined the engineering department of the Western companies.

Business Notes

WORTHINGTON PUMP & MACHINERY CORPORATION, Harrison, N. J., reports a net income of $2,056,093 for the year ended Dec. 31, 1930, with a net surplus of $5,693,665.49 on that date. Total billings for the year were 9 per cent less, it is stated, while profit on billings from manufacturing and trading was only one-tenth of one per cent less than in the preceding year.

LINK-BELT COMPANY, Chicago, Ill., announces the appointment of the Stockland Equipment Sales Company, 2628 University Ave., S.E., Minneapolis, Minn., as its shovel-crane-dragline agent in Minnesota (excepting a few counties around Duluth) and part of west-central Wisconsin. The Philadelphia division of the company announces the appointment of Joe C. Tucker, Morganfield, Ky., as its sales agent for conveyors and loaders in that territory.

UNITED CONVEYOR CORPORATION, Chicago, Ill., announces the formation of a Canadian company under the name of the United Conveyor Corporation of Canada, Ltd., with headquarters at 7 Queen Street East, Toronto, Ont.

STERLING ELECTRIC MOTORS, Los Angeles, Calif., announces the appointment as sales manager of John R. Howell, who has been a member of its sales organization for some time.

EDWARD VALVE & MANUFACTURING COMPANY, East Chicago, Ill., announces the appointment of Bell & Eiss, Inc., 430 Oak Grove Ave., Minneapolis, Minn., as its sales representative in the territory tributary to the Twin Cities.

How's Business?

SLOW BUT STEADY seasonal improvement continues undisturbed by new developments. Steel production, supported by diverse short-range demand, is rising to its spring peak at somewhat more than its usual seasonal rate; and building is beginning to reflect the strong stimulus of public works contracts. Check payments show the effects of abnormally high government financial turnover. Other indicators continue monotonously horizontal, and domestic textile activity is apparently tapering off a bit. Our index has risen again, above the level of recent weeks, to 81.1% of normal, where it was early in the year. Commodity price movements are encouragingly indefinite, as in March last year, but the spectacular strengthening of silver and an advance in steel are possibly significant.—*The Business Week*, March 25.

WITH THE SOCIETY SECTIONS

A.S.M.E., Anthracite-Lehigh Valley Section Meeting and exhibition at the Hotel Altamont, Hazelton, Pa., on Saturday afternoon and evening, April 18. General subject: "Practical Industrial Lubrication." A large number of manufacturers are expected to exhibit small lubricating devices and equipment. Manager, C. W. Bell, 177 East Broad St., Hazelton, Pa.

A.S.M.E., Metropolitan Section. Meeting in the Engineering Societies Building on April 29 at 8 p.m. Subject: "Developments of the Stationary Diesel Engine Under the Conditions of American Power Economics," by Julius Kuttner, editor of *Diesel Power*.

A.S.M.E., Ontario Section. Joint meeting with the Hamilton and Niagara Branches of E.I.C. and the Buffalo Section, A.S.M.E., in Hamilton, Ont., on April 2 at 2 p.m. Plant inspection trips in the afternoon followed by dinner and address in the evening. Subject: "Steam Storage," by J. P. Wys, Ruths Steam Storage Limited.

A.S.M.E., Syracuse Section. Meeting at the Onondaga Hotel roof garden on March 30 at 8 p.m. Subject: "Some Phases of the Present Economic Situation as It Pertains to Unemployment," by Ralph E. Flanders, Jones & Lamson Machine Tool Company.

A.S.R.E., Boston Section. Meeting at the Massachusetts Institute of Technology on March 26. Subjects: "Corrosion," by Professor H. O. Forrest, M.I.T.; and "Flaked Ice," by Crosbie Field, Flake Ice Corporation. The meeting will be preceded by a dinner at the Riverbank Court Hotel.

Trade Catalogs

RESEARCH—A short history of the Pittsburgh Testing Laboratory, with headquarters in Pittsburgh, Pa., and a description of the services it performs in the field of investigation and research, are contained in a profusely illustrated booklet recently issued by the laboratory, entitled "Fifty Years of Service to Industry."

PULVERIZED COAL HANDLING—A new illustrated catalog, No. 903, describing the construction and application of the Fuller-Kinyon system to the transportation and distribution of pulverized coal, has just been issued by the Fuller Lehigh Company, 85 Liberty St., New York City.

UNIT HEATERS—The Young Radiator Company, Racine, Wis., has recently published a new booklet, No. H-1230, describing and illustrating a complete line of unit heaters covering large and small applications. Efficiency tabulations and installation diagrams are included in the bulletin.

STEAM PURIFIERS—Bulletin No. 9-P, recently issued by the Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa., describes steam purifiers and oil separators for removing moisture and impurities from live steam.

STOKERS—The subject of economical and automatic heating of schools is thoroughly covered in an illustrated bulletin just published by the Detroit Stoker Company, General Motors Building, Detroit, Mich. The illustrations show the wide variety of schools and the different types of Detroit stokers used to solve their varied heating problems.

BOILERS—The Bigelow Company, New Haven, Conn., has just issued its 1931 catalog covering water-tube boilers, economizers, two-pass boiler, water walls, vertical three-drum boiler, electric steam generator, low-head water-tube boiler, and horizontal return-tubular boiler. The catalog is conveniently tab-indexed and illustrated in color.

Fuel Prices

FUEL OIL

Boston—March 16, tank-car lots, f.o.b. 12@14 deg., Baumé, 2.95c. per gal.; 28@32 deg., 4.95c. per gal.

New York—March 19, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, contract, 6c. per gal.

Philadelphia—March 11, No. 4, light, $1.31 per bbl.; No. 5, medium, $1.22; No. 6, heavy (Bunker C), $1.10.

Pittsburgh—March 11, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c@3.5c. per gal.; 36@40 deg., 3.125c.@3.5c.

Cincinnati—March 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—March 4, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 53.75c. per bbl.; 22@26 deg., 62.5c. per bbl.; 26@28 deg., 72.5c. per bbl.; 28@30 deg., 83.75c. per bbl.

St. Louis—March 11, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.445 per bbl.; 28@30 deg., $1.545 per bbl.; 30@32 deg., $1.645 per bbl.; 32@36 deg., gas oil, 3.526c. per gal.; 38@40 deg., distillate, 4.276c. per gal.

Dallas—March 14, f.o.b. local refinery 24@26 deg., $1.05 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.00
Smokeless, slack	Chicago	1.00 @ 1.35
Harlan, Ky., slack	Chicago	.80 @ 1.00
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	.80 @ 1.25
W. Ky., slack	Louisville	.65 @ .75
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.00
Smokeless, slack	Cincinnati	1.00 @ 1.25
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.75 @ 1.10
Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Blytheville — City Council, is having plans prepared for the construction of sanitary sewage system including disposal plant, pumps, etc. Estimated cost $70,000. E. J. Heaton, is engineer.

Calif., Los Angeles—City is having plans prepared for sewage treatment work including pumping plant, two 4 in. pumps, etc. Estimated cost $100,000. W. K. Foster, Klinker Bldg., is chief engineer.

Colo., Grand Junction—City Council, H. C. Tomlinson, Clk., plans the construction of a power plant. Estimated cost $750,000. Wood & Weber, 810 14th St., Denver, are engineers.

Ill., Chicago—Byllesby Engineering & Management Corp., 231 South La Salle St., H. Erickson, V. Pres., in charge of operation, announces that Standard Gas & Electric Co.'s construction budget for 1931 totaling $45,068,951 has been allocated among various subsidiary and affiliated companies as follows: California Oregon Power Co., $5,100,004; Louisville Gas & Electric Co., $3,100,066; Mountain States Power Co., $1,115,530; Northern States Power Co., $10,803,809; Oklahoma Gas & Electric Co., $3,577,502; San Diego Consolidated Gas & Electric Co., $2,271,060; Southern Colorado Power Co., $240,357; Wisconsin Public Service Corp., $1,508,245; Wisconsin Valley Electric Co., $1,027,474; Philadelphia Co., $14,028,096; other construction expenditures, allocation not completed $2,296,808.

Ill., Chicago—Wieboldt Realty Trust, awarded contract for a 13 story apartment building at Adams St. and Ashland Ave. to R. C. Wieboldt, 1412 West Washington Blvd. Estimated cost $1,500,000.

Ind., Fort Wayne — St. Vincents Orphans Home, c/o J. F. Noll, is having plans prepared for the construction of an orphans home including power plant and equipment at Wells St. and Archer Ave. Estimated cost $500,000. A. M. Strauss, 415 Cal-Wayne Bldg., is architect.

Ia., Dallas Center—City plans an election on or after April 15 to vote $66,000 bonds for waterworks improvements including deep wells at Racoon River, pumps, tank on tower, etc.

Mass., Athol — Athol Gas & Electric Co., Main St., plans the construction of a power sub-station at Old Main St. Estimated cost $40,000. Private plans. Maturity indefinite.

Mass., Boston—Bureau of Yards & Docks, Navy Dept., Washington, D. C., received lowest bid for motor generator sets and switchboard from F. A. Mazzur Co. Inc., 141 Milk St. $60,000.

Mass., Lowell—Lowell Electric Light Corp., J. A. Hannewell, Pres., 35 Market St., is having plans prepared for the construction of a service building on Perry St. Estimated cost $125,000. New England Power Association, 89 Broad St., Boston, is engineer.

Mass., Martha's Vineyard—Cape & Vineyard Electric Co., P. H. House, Supt., is having plans prepared for addition to power plant. Estimated cost $40,000. Associated Gas & Electric System, 46 Blackstone St., Cambridge, is engineer.

Mass., Springfield — Commanding Officer, Springfield Armory, will receive bids about Apr. 10 for the construction of a steam power plant at Hill Shops. Estimated cost $105,000. Private plans.

Montana—L. B. O'Neil, Cut Bank, Anaconda Copper Mining Co., C. F. Kelley, Pres., Montana Power Co., J. D. Ryan, Pres., Butte, signed contracts Feb. 27 for a 230 mi. pipe line from Butte to Cut Bank including compressor stations, distribution systems, etc. Main pipe line to be constructed by L. B. O'Neil and supply systems by Montana Power Co. Estimated cost approximately $12,000,000. H. W. Parmelee, Cut Bank, is engineer.

Mo., Joplin—Bd. of Education, S. A. Harris, Secy., will receive bids until Mar. 31 for the construction of a junior high school including boiler room, etc. at Gray Ave. and First St. Estimated cost $250,000. T. W. Williamson & Co., Farmers National Bank Bldg., Topeka, Kan., are architects. B. F. Cook, 713 Linwood Blvd., Kansas City, is engineer.

Mo., Perryville—City, P. Zoellers, Mayor, is having preliminary surveys made for the construction of a complete light and power plant, also distribution system including power plant building, generating equipment, etc. Russell & Axon, 6200 Easton Ave., St. Louis, are engineers.

Neb., Grand Island—City, H. E. Clifford, Clk., awarded contract for the construction of a sewage disposal plant including pump and blower house, etc. to Chambers Construction Co., 701 First National Bank Bldg., Lincoln, $125,000.

N. H., Exeter—Phillips Exeter Academy, L. Perry, will soon award contract for construction of a central heating plant. Estimated cost $25,000. R. D. Kimball Co., 6 Beacon St., Boston, Mass., is engineer.

N. J., Newark—Treasury Dept., Washington, D. C., plans the construction of a post office and federal building including steam heating system, etc. at Franklin and Walnut Sts. Estimated cost $6,150,000. J. H. and W. C. Ely, 605 Broad St., Newark, are architects.

N. J., Skillman—Dept. of Institutions & Agencies, Trenton, received lowest bid for the construction of steam distribution lines at power house, State Village for Epileptics here from G. J. Tobin, 187 North Ave., Plainfield. $37,217.

N. Y., Central Islip—Dept. of Mental Hygiene, State Capitol, Albany, awarded contract for construction, service connections (tunnels) additional power house, etc. at Central Islip State Hospital here to Brady Concrete Corp., 25 West 45th St. $346,400.

N. Y., Garden City—Doubleday, Doran & Co. Inc., awarded contract for the construction of a power house to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $150,000.

N. Y., New York—Dept. of Hospitals, Municipal Bldg., will receive bids about May 1 for the construction of a refrigeration plant at Randalls Island. Estimated cost $40,000. Van Wart & Wein, 347 Madison Ave., are architects.

N. Y., New York—Dept. of Hospitals, Municipal Bldg., plans 40 x 80 ft. addition to boiler house and stack at Walfare Island. Estimated cost $85,000. W. H. Gompert, 101 Park Ave., is architect. K. M. Murchison, 101 Park Ave., is engineer.

O., Cleveland—John Carroll University, J. J. Bernett, Chn. of Building Comn., will soon award contract for the construction of a group of buildings, including administration and dormitory building, service buildings, etc., at Warrensville Center Rd. Estimated cost $2,000,000. P. L. Small, Inc., Terminal Tower, is architect. G. S. Rider Co., Marshall Bldg., is engineer.

Okla., Vinita—Independent Power & Light Co., has made application for franchise to construct an electric light and power plant. Estimated cost $150,000. Private plans.

Pa., Pottstown—City awarded contract for the construction of a sewage treatment plant and pumping station to Seeds & Durham, 25 Maplewood St., Philadelphia. $174,341; also equipment for filter plant to Roberts Filter Mfg. Co., 6th and Columbia Sts., Darby. $113,640.

Tex., Beaumont—Decker Packing Co., c/o E. S. Selby, Mgr., Mason City, Ia., is having plans prepared for the construction of a cold storage plant on Crockett St. Estimated cost $70,000. R. C. Heartfield, Goodhue Bldg., Beaumont, is engineer.

Tex., Port Aransas—Gail Borden Munsill Interests, New York, N. Y., awarded contract for the construction of an oil unloading dock, 402 ft. long and 40 ft. wide, including electrically driven pump to W. Richardson, Port Aransas. $100,000.

Tex., San Angelo—O. D. Dillingham, Abilene, plans the installation of a 20-ton ice plant here. $30,000. Private plans.

Tex., Waco—U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., awarded contract for a group of buildings including boiler house, refrigeration plant, water softening plant, etc. at U. S. Veterans Hospital here to H. B. Ryan Co., 500 North Dearborn St., Chicago, Ill. $824,900.

Wis., Milwaukee—O. H. Henschel, 401 Commerce Bldg., consulting engineer for Industrial District central power plant to serve six or seven manufactories near here. Initial installation will include four 400-hp. stoker fired boilers, operating at 300 lbs. pressure and auxiliary equipment. Plans and specifications are now being made.

Ont., Simcoe—Norfolk Fruit Growers Association, plans 3 story addition to fruit handling and cold storage plant. Estimated cost $100,000. E. H. Darling, Pigott Bldg., Hamilton, is engineer.

Equipment Wanted

Boilers, Stokers, Engine, Etc.—Michigan City, Ind.—Bd. of Trustees, Indiana State Prison, W. H. Daly, Warden, will receive bids until Apr. 2 for furnishing and installing new water tube boilers, mechanical stokers, steam engine or turbine with generator, electrical switchboard, transformers, feed water pump, blower fan and forced draft equipment, boiler feed pump and miscellaneous boiler room equipment.

Electric Motors, Etc.—Providence, R. I.—H. Leach, 295 Dyer St., plans to purchase electric motors, belting, shafting and hangers.

Engine—Stoneham, Mass.—Purchasing Committee, Town Hall, will receive bids until Apr. 2 for motor pumping engine.

Pump—Beverly Hills, Calif.—City Council, will receive bids until Apr. 7 for furnishing and installing deep well turbine pump for waterworks.

Pumps—Millstadt, Ill.—City will receive bids about May 15 for a deep well pump, high service pumps, etc. in connection with waterworks improvements. $47,000.

Pump, Etc.—Galveston, Tex.—City plans to purchase new water pump for proposed waterworks improvements.

Pumps—London, Ont.—Public Utilities Commission, E. V. Buchanan, Gen. Mgr., will receive bids about April 15 for two 2 m.g.p.d. electrically driven pumps for waterworks.

Pumps, Etc.—Woburn, Mass.—City plans to purchase pumps, etc. for proposed extension to waterworks. Estimated cost $110,000.

Industrial Projects

Ill., Peoria—Murison Label Co. Inc., R. I. Bentley, V. Pres., Commercial National Bank, awarded contract for a 1 story factory including 35 x 96 ft. boiler room, etc. to W. M. Allen Son Co., Jefferson Bldg. Estimated cost $150,000.

Ind., Hammond—Standard Steel Specialty Co., awarded contract for a 1 story, 50 x 200 ft. addition to factory at Clark Ave. and 142nd St. to F. C. Rowley, First Trust Bldg. Estimated cost $42,000.

Mass., Wellfleet—Powdrell & Alexander Inc., 175 Connecticut Mills Ave., will build a 2 story factory at Main St. Ext. Estimated cost $40,000. W. B. Brennan, 175 Connecticut Mills Ave., is engineer. Work will be done by day labor.

N. J., Allwood—American Colortype Co., 207 West 25th St., New York, N. Y., acquired the Brighton Mills plant and plans addition and alterations here. Estimated cost $40,000. Ballinger Co., 100 East 42nd St., New York, is architect and engineer.

N. J., Ridgefield Park—Continental Paper Co., River Rd., Bogota, is receiving bids for the construction of a 2-story paper plant here. Estimated cost $40,000. Johnson & Wierk, Grand Central Terminal, New York, N. Y., are architects.

N. Y., Endicott—International Business Machines Corp., 270 Broadway, New York, plans the construction of a 4 story, 50 x 56 ft. addition to factory. Estimated cost $100,000. C. Higgins, 101 Park Ave., New York, is architect.

O., Youngstown—Youngstown Sheet & Tube Co., Stambaugh Bldg., plans the construction of a new continuous sheet mill. Estimated cost $1,000,000.

Pa., Oil City—Oil City Boiler Works, plans addition to manufacturing plant. Estimated cost $50,000.

Pa., Pittsburgh—Smith Faris Co., 1150 Hodgkiss St., manufacturers of asbestos, will soon award contract for a 1 story, 26 x 83 ft. factory at 1159 Hodgkiss St. Estimated cost $40,000. Private plans.

Tex., Houston—Southwestern Can Co., c/o H. O. Westward, V. Pres., 1207 Mary St., will receive bids until Mar. 26 for the construction of a 1, 2 and 3 story, 180 x 375, 101 x 180 and 51 x 46 ft. factory and office at Greenwood and Canal Sts. J. Finger, 711 National Standard Bldg., is architect. W. P. Moor, Kress Bldg., is consulting engineer.

Wash., Seattle—Elliott Bay Mill Co., 600 West Spokane St., manufacturers of gates, valve bags, etc. awarded contract for a 1 story, 140 x 148 ft. factory to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $60,000.

Ont., Hamilton—Grasselli Chemical Co. Ltd., Burlington St. E., awarded contract for the construction of a superphosphate plant including 1 story, 120 x 240 ft. manufacturing building and 1 story, 80 x 270 ft. rock storage building, to Anglin-Norcross Ltd., Temple Bldg., Toronto. Estimated cost $75,000.

Ont., Leaside—Tremco Mfg. Co. of Canada Ltd., c/o W. H. Reid, 81 Victoria St., Toronto, awarded contract for a 2 story, 45 x 100 ft. factory for the manufacture of caulking, glazing and waterproofing compounds to Gatehouse Bros. Ltd., 86 Adelaide St. E. Estimated cost $50,000.

Que., Montreal—Hackbridge Electric Construction Co. Ltd., C. H. W. Biskelorn, V. Pres., Walton-on-the-Thames, England, plans the construction of a plant for the manufacture of transformers and rectifiers here.

Que., St. Hyachinthe—Hump Hairpin Co. of Canada Ltd., 1918 Prairie Ave., Chicago, Ill., awarded contract for the construction of a 2 story, 234 x 80 x 120 ft. factory here to Dakin Construction Co., 270 Beaumont St., Montreal. Estimated cost between $80,000 and $90,000.